ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. LIV. No. 14. 220 Broadway, New York, October 5, 1905.

TABLE OF CONTENTS

	Page
LEADING ARTICLES:	
The Zambesi River Bridge, Victoria Falls, Rhodesia (illustrated)	339
The Manufacture of Concrete Blocks and Their Use in Building Construction; H. H. Rice	341
The Action of Capped Armor-Piercing Shell (illustrated); Eugen Kodar v. Thurnwerth	346
Smoke Abatement at Indianapolis	348
New Concrete Ties and Steel Ties (illustrated)	349
Steam Motor Cars on the Taff Vale Ry., England (illustrated)	350
Tunnel Construction and the Subsidence of Streets in Chicago	351
The "Sea-Mills" of Cephalonia (illustrated); Wm. P. Mason	352
The Influence of Arsenic in Pickling Solution; Charles F. Burgess	352
Results of Tests of Fireproof Wood at the Insurance Engineering Experiment Station	353
A New Form of Elastic Metal Gasket for High Pressures (illustrated)	354
Annual Convention of the American Street Railway Association and Affiliated Societies at Philadelphia, Pa.	358
A Wooden Track-Brake Shoe Used on San Francisco Street Railway Cars (illustrated)	359
A Push Cart for Transporting Concrete (illustrated)	359
A Condenser for Shaft-Sinking Pumps and Mine Pumps (illustrated)	360

	Page
EDITORIAL	355
Announcement of Prize Winners, Concrete Block Competition—Scope and Character of Papers Submitted in Concrete Block Competition—Street Tunnels and Building Subsidence in Chicago—Sanitary Science as Practiced in the Japanese Navy—The Court Decision on the Williamsburg Bridge Penalty Clause Suit.	
Concerning the Work of the Street Railway Conventions	356
LETTERS TO THE EDITOR	357
The Record of Speed in Shaft Sinking; H. S. Patterson—The Labor Problem in the South; Geo. B. Hazlehurst—A Table for Finding the Length of One Side of Any Polygon Inscribed in a Circle (illustrated); C. L. Bogert—Is It Permissible to Calk or Sledge Loose Rivets in Structural Work? (illustrated); Subscriber—Notes and Queries.	
ENGINEERING MATERIAL PRICES	360
NOTES FROM THE ENGINEERING SCHOOLS	360
ENGINEERING NEWS OF THE WEEK	361
PERSONALS	362
ENGINEERING SOCIETIES	362

THE ZAMBESI RIVER BRIDGE, VICTORIA FALLS, RHODESIA.

The great steel arch bridge designed to carry the northern extension of the Rhodesia Railways across the gorge of the Zambesi River just below the famous Victoria Falls in South Africa, was opened to traffic on Sept. 2, 1905. The 500-ft. span of the Zambesi arch ranks it among the large steel arch bridges of the world. To this feature of interest is added the novelty that the bridge was erected thousands of miles from its place of manufacture and in a part of the world which not many years ago had been reached only by a few intrepid explorers. It is because of its technical interest as an example of purely British steel arch design, however, that we have obtained from one of the engineers of the work and from our English contemporary, "Engineering," the following description and illustrations, and present them here.

GENERAL DESCRIPTION—The location of the Zambesi bridge is shown by Fig. 1. The river coming in a broad shallow stream from the north drops suddenly into a chasm reaching transversely across the waterway. The fall takes place in four cataracts separated by islands just as Green and Goat Islands separate the American and Canadian Falls at Niagara. Towards its eastern end the southern wall of this transverse chasm is broken through by a deep gorge supposed to be the fissure formed by an earthquake. This gorge is said to extend southward for 20 miles, and it forms the southern outlet for the river. The new bridge crosses the gorge at a point about 2,100 ft. below the cataract; the width here is 650 ft. and the depth to water level is about 400 ft. The map, Fig. 1, shows the railway location and the adjacent topography.

The bridge proper is a two-hinged spandrel braced arch flanked on both ends by short truss spans. Fig. 2 shows a plan and elevation of the structure. The two engravings given by the picture on this page and Fig. 3, also indicate the general character of the structure. Its main dimensions are contained in the following tabular statement:

	Ft.	Ins.
Span of main arch	500	0
Rise at crown	90	0
Depth of main arch at bearings	105	0
Depth of main arch at crown	15	0
Width between centers of main arches at top	27	6
Width between centers of bearings	53	9
The main arch is divided into twenty bays of	25	0
Spans of end spans.....87 ft. 6 ins. and	62	6
Width between centers of girders	20	0
Depth of main girders	12	6
The end spans are divided into bays of	12	6
Clear width of roadway	30	0
Batter of main arches	1 in 8	
Curve of main arch	parabolic	
Camber of main arch at 60° F.	9 ins.	

The Cleveland Bridge & Engineering Co., Limited, were the successful contractors both for the supply of the steel work and the erection of the bridge, from the specifications of Sir Douglas Fox, M. Inst. C. E., Hon. M. Am. Soc. C. E., and partners; Sir Charles Metcalfe, Bart., M. Inst. C. E., and Mr. G. A. Hobson, M. Inst. C. E.

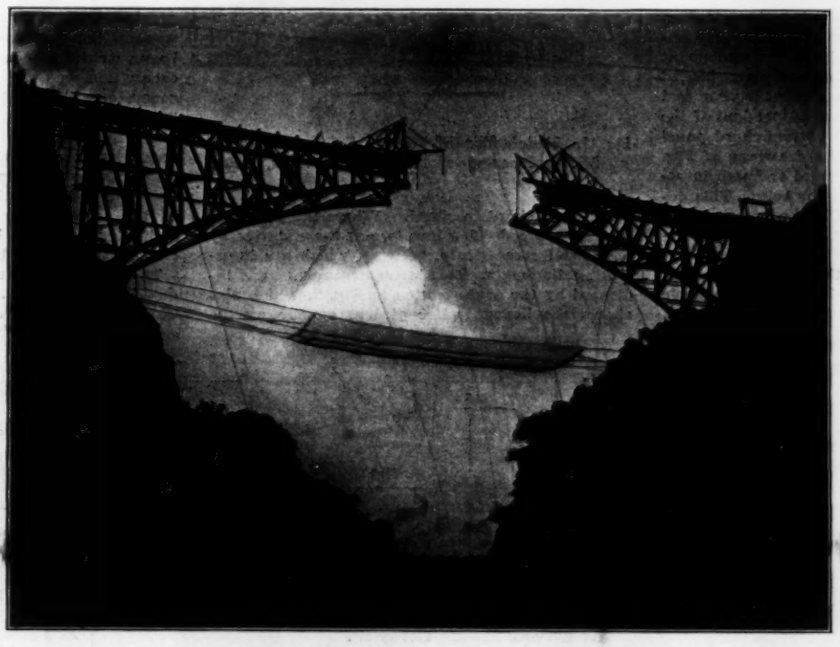
DESIGN AND CALCULATION.—The design of the bridge was worked out by Mr. G. A. Hobson. The conditions made an arch bridge of some form practically necessary, and the designer chose a two-hinged arch in preference to a three-hinged arch principally because he considered that a more rigid and consequently a more durable bridge would be obtained by this choice. It was realized that the difficulties of calculating the stresses in a two-hinged arch were much the greater, and that it would be more difficult to ensure that the structure when erected would take its correct stresses, but it was felt that neither desideratum was impossible and that the resulting economy of cost warranted the extra trouble.

In calculating the structure the following loads were assumed in addition to the dead load: (1) A train of two engines followed by cars on each track; an average weight of 3,136 lbs. per foot of track; (2) stresses due to a variation of temperature of 60° F. each way from mean temperature; (3) stresses due to a wind pressure of 30 lbs. per sq. ft. on train and bridge, or 45 lbs. per sq. ft. on bridge alone; calculated on entire area of both arch trusses with allowance for unequal distribution of pressure. The stresses were calculated by the method described by Prof. Clerk-Maxwell in the "Encyclopedia Britannica."*

A feature that had to be kept in mind generally throughout the design was that the parts of the bridge had to be taken across the gorge by some temporary expedient. As noted later a cableway was decided upon for this conveyance; to meet the working conditions of this device the maximum weight of each item was fixed at 10 long tons. The designs, as shown in Figs. 2 to 17, will now be considered in detail.

SKEWBACKS.—The ends of the arch trusses rest on steel skewbacks carried by concrete pedestals. The assembled structure is shown by the drawing. Fig. 4. The importance of the details may be appreciated from the statement that its duty will be to transmit in each case a thrust of 1,600 long tons to the foundation rock. Referring to Fig. 4 it will be seen that the assembled structure consists of the following parts. (1) A bent plate to receive the ends of the arched chord and the end post; (2) two forged steel I-beam shaped pillars supporting the bent plate; (3) a forged steel saddle resting on the end pin and carrying the pillars; (4) the end pins; (5) a cylindrical bearing for the end pin; (6) a triangular shaped pedestal supporting the pin seat, and (7) a base plate supporting the pedestal.

Details of the base plate are shown by Fig. 5 Great care was taken to make this number perfectly true by having all the bearing surfaces planed after the parts had been riveted up. It was set in position and carefully adjusted to level distance, elevation, etc., by wedges; then neat current grout was put in under pressure over the area through the system of pipes indicated by the dotted lines. Details of the triangular pedestal are shown by Fig. 6; it need only be noted in addition to the drawing that the bottom bearing surface was planed and the curved sockets for the pin seat were machined true to line and surface. In these pockets rests the pin seat or bearing, Fig. 7; this is a steel forging in the form of a half tube machined both inside and out. The tube is 2 ins. thick and fastened to the pedestal by countersunk bolts in oval bolt holes for vertical adjustment. It will be noticed that the



VIEW OF ZAMBESI ARCH BRIDGE DURING ERECTION.

*This method is described in detail in "Trusses and Arches," by Prof. Charles E. Green.

tube is recessed in the center to correspond with a projection in the middle of the end pin, and thus give a check to any considerable lateral movement of the pin.

The end pin is a steel forging 12 ins. in diameter and 5 ft. 10 ins. long with a 3-in. hole subsequently bored through the center. During construction a bolt was passed through this hole, with a washer on each end bearing against a ring or clip (Fig. 7), to hold the pin from slipping Details of the saddle resting on the pin are shown by Fig. 8. It will be noted also that in order to take the vertical thrust of the half-arch during its erection as a cantilever a plate 1 in. thick and 14 ins. wide (Figs. 4 and 5) was riveted to the top of the base plate. The pedestal was supported against this plate by wedges, which permitted of adjustment in the span or level of the pedestal after the base plate had been set. The pillars and plate carrying the end post and the arched chord are shown in detail by Fig. 9 and Fig. 10, respectively. In conclusion, it may be noted that the end pin is so proportioned as to limit the bearing pressure to 5,600 lbs. per sq. in., while the base plate gives a bearing pressure on the masonry of 20 long tons per sq. ft.

ARCH TRUSSES.—The arch trusses incline toward each other at an inclination of 1 in 8 from the vertical, and each, as shown by Fig. 2, is divided into twenty 25-ft. panels. Each is composed of a straight top chord and a parabolic bottom chord connected by a web system of vertical posts and diagonal tension members. Fig. 11 shows a typical panel construction. The chord sections consist of two parallel channel sections connected by transverse diaphragms at three points in each panel length and having lattice bars on top and bottom. The posts and diagonals have the same character of sections as the chords except that no transverse diaphragms are inserted. The object in latticing the tension diagonals was to reduce vibration. It is also important to notice that all chord connections at panel points are made with accurately planed butt joints but also with sufficient rivets and covers to take the entire stress independent of the butt joints. Typical top and bottom chord panel point details are shown by the drawings of Fig. 12. It will be noted that the chord and web intersections are provided with pins or bolts. This device was employed to simplify the erection and secure accuracy of alinement. The pin was designed to be as light as possible (it having to be inserted in an awkward position and at a critical moment) and be strong enough to carry the whole panel. Details of the pin are shown by Fig. 13.

the planes of the chords and also sway bracing between each pair of opposite posts. The character of this bracing is indicated quite clearly by the plan, Fig. 2, and the details of Fig. 11. The sway bracing, where the posts are short, as shown by Fig. 11, consists of intersecting diagonals from chord to chord. Where the posts are long they are divided into two or more stories by horizontal cross-struts, between which are intersecting diagonals. This latter arrangement is indicated by the cross section in Fig. 2, which also shows the heavy lattice girders connecting the

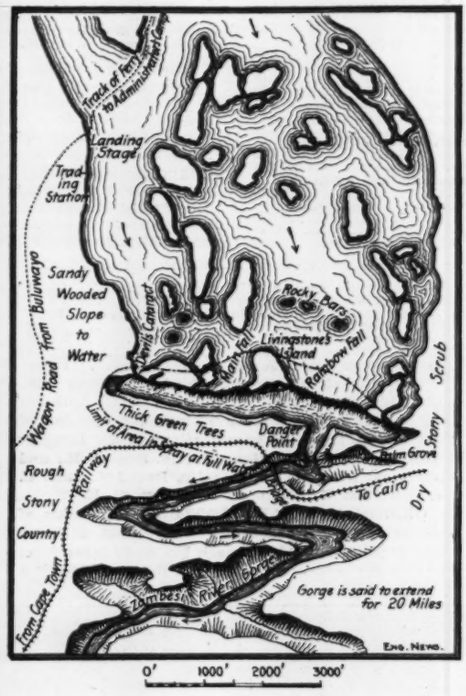


Fig. 1. Sketch Map of Victoria Falls and Railway Bridge Crossing of the Zambesi River, South Africa.

rail is carried in a trough composed of two parallel channels resting on the transverse plate girders or floor beams. Fig. 15 is an enlarged detail of the rail trough. It will be seen that this construction provides a guard rail and ensures drainage. Between the rails the space is covered by a dished steel plate, and all other parts are floored with timber. The hand railing construction is shown clearly by Fig. 11.

MATERIALS.—The actual weight of the Zambesi Bridge, exclusive of rails, was 1,637 long tons. The approximate distribution of the steel work was as follows:

Main girders, central span, tons	1,0[illegible]
Main girders, end spans, tons	[illegible]
Cross girders, tons	[illegible]
Deck rail bearers and parapet, tons	[illegible]
Bracing, tons	[illegible]
Bearings, including pins, tons	[illegible]
Baseplates, tons	[illegible]
Rolled joists and bars in concrete, tons	[illegible]
Foundation bolts, tons	[illegible]
Bolts, nuts, and washers, tons	[illegible]
Expanded metal for railings, sq. yds.	[illegible]

Acid open hearth steel was employed throughout, classified as rolled steel and rivet steel. The rolled steel was required to contain not more than 0.06% phosphorus, and be capable of sustaining an ultimate tensile stress of 67,200 lbs. (30 gross tons) per sq. in., no specimen showing a greater variation of strength from this figure than 7%. The elongation before fracture was required to be not less than 20% in 8 ins., and the reduction in area at fracture from 45 to 55%. Rivet steel was required to have an ultimate tensile strength of not less than 58,240 lbs. per sq. in. and not more than 67,200 lbs. per sq. in. Rivet holes were required to be drilled and all rivets wherever practicable were required to be machine driven.

ERECTION.—Previous to the shipment of the steelwork all the essential parts of the arch proper were assembled in the shop yards to make certain that everything was complete and accurate. At the bridge site the first work done was on the skewback foundations. Work was begun on the foundations in December, 1903, and excavation was completed in August, 1904. The concrete work was begun in May and completed in October, 1904; there were about 600 cu. yds. of concrete work. By December, 1904, the falseworks for the erection and support of the end posts of the main span were completed, and the actual erection of the arch begun. The closure of the arch was made on April 1, 1905. The estimated and actual progress of erection of the steel arch is shown by the diagram, Fig. 16.

The method of erection of the arch span was devised by Mr. A. C. Imbault, Engineer in Charge for the Contractors. It was to erect the

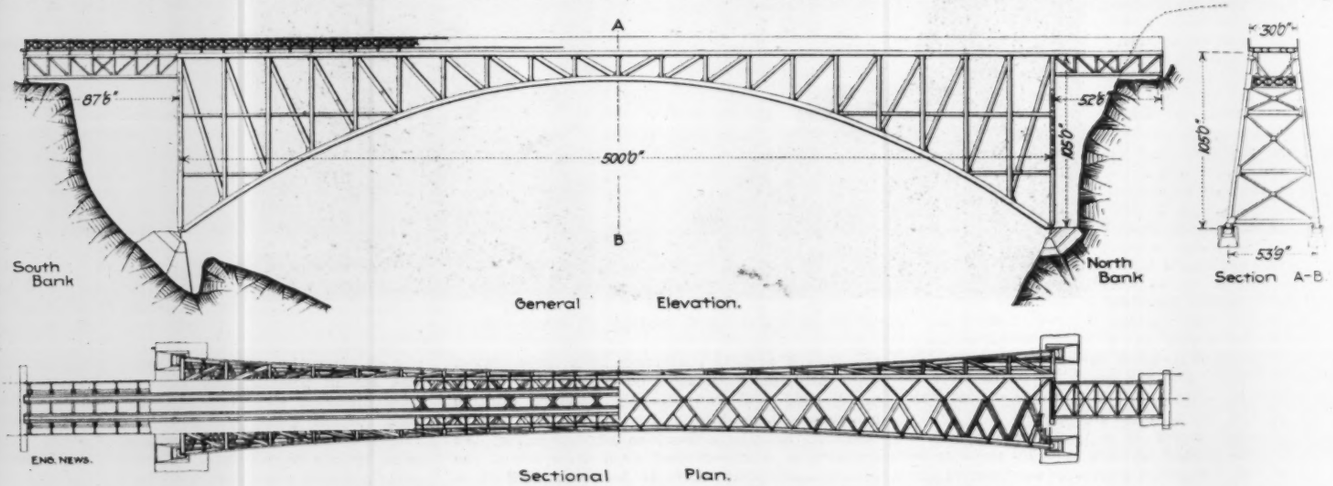


FIG. 2. PLAN AND ELEVATION OF STEEL ARCH BRIDGE OVER ZAMBESI RIVER.

In reference to the arch truss design in general it needs to be noted that great care was exercised to secure simple sections; there are no inclosed or hidden spaces in any part, so that every inch of the members, inside and out, is accessible to the painter's brush. The latticing takes no stress in any of the members.

LATERAL AND SWAY BRACING.—The arch trusses have lateral systems at top and bottom in end posts near their tops and serving as support to the end span trusses.

FLOOR CONSTRUCTION.—As shown by Fig. 11, the floor construction consists of transverse plate girders spaced 12½ ft. apart with the ends beveled on the underside to fit the inclination of the chord tops. An enlarged detail of this arrangement is shown by Fig. 14. The tracks are spaced 10 ft. 10 ins. apart on centers, and each skewback and end post bent for each end of the arch by means of falseworks. A pin was then set through the top of each of the four end posts. To each of these pins was attached twelve 1¼-in. steel ropes, which were carried back and anchored in a vertical pit with concrete. The attachments of the ropes to the end pins were so designed that they could be adjusted to either elevate or depress the work. The end post bents

being erected, the remainder of the half arch on both sides of the river was built out as a cantilever.

The material was all received at one end (the south bank) of the work, and that portion for the north half arch was taken across the gorge by a cableway, as described in our issue of May 12, 1904. The maximum load generally carried was 7 tons, but the cableway was tested up to a 10-ton load. The cableway necessitated the development of 20 HP. to transport 7 tons and of 25 HP. to transport 10 tons. A 10-ton electric crane was used on each half-arch to handle the members in erection. These cranes are shown in the view Fig. 4. Electricity for power, etc., was generated by a steam plant and not by the power of the falls. It will be noticed from Fig. 3 that use was made of a net under the work to catch falling tools, and particularly to give safety and confidence to the workmen. The total cost of the bridge complete was £70,000.

For the information from which this description has been prepared we are indebted to Mr. C. Corner, M. Inst. C. E., Assoc. M. Am. Soc. C. E., Resident Engineer, Maintenance Rhodesia Rys., Northern Extensions, and to London "Engineering," July 7 and July 21, 1905.

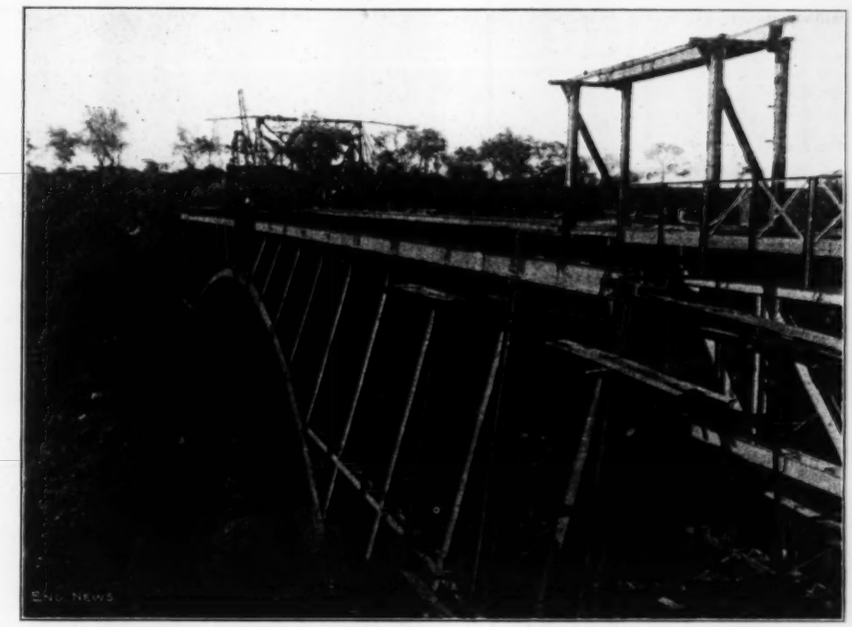


FIG. 3. VIEW OF ZAMBESI ARCH BRIDGE, SHOWING ERECTION TRAVELERS.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION.*

First Prize Paper in Engineering News Competition.

By H. H. Rice.†

CONCRETE.

In any discussion of concrete blocks a clear conception of the theory of concrete is essential. We have heard and read a great deal of "artificial stone," and I wish that we might forget the term and banish from our minds the idea it conveys. I would that we might rather embrace the thought of concrete as a union of certain elements scientifically combined to form a material useful in construction because of its own distinctive merits, and not because of its resemblance to any other natural or artificial product. I am convinced that the effort toward imitation has caused half of the evils in connection with concrete construction. If we take it for what it is, rather than what it resembles, we shall find qualities, uses and advantages worthy of exhaustive research. Concrete is neither more nor less than a form of masonry readily adaptable to a large variety of uses because of the facility of production in any desired size or form. On account of the large number of aggregate members and the diversity in their shape and size, it requires the application of certain scientific methods in relation to the mortar, which are not required in masonry as the latter term is popularly used. The underlying principle of good concrete construction is that every particle of sand shall be thoroughly coated with cement, and that every piece of gravel or broken stone shall be thoroughly coated with the mixture of sand and cement. To the observance of this principle we must closely adhere if we would avoid those evils which have often followed the use of defective concrete, and by faithful adherence to this basic rule we shall produce a constructive material possessing such marked distinctive advantages that it easily rests upon its own merits.

MATERIALS.

In considering the materials used in the manufacture of concrete blocks, cement claims our first attention. The use of cement in concrete construction is first actively brought to our notice by the Romans. They discovered that calcined clay finely ground and added to lime produced a substance which would set under water. The volcanic dust found near the village of Pozzuolo afforded an excellent hydraulic base for this lime-mortar, and the cement came to be called Puzzuolani. Modern orthographers have abbreviated this to Puzzolan, and the latter term in modern practice denotes any cement produced by the intimate mixing and grinding to extreme fineness, without subsequent calcination, of furnace slag, volcanic dust or burned clay and powdered hydrates of lime. Puzzolan cement attains great strength and toughness, but never becomes hard like a true Portland cement. It is not adapted for use except under water or in places where it can be constantly moist, as a dry atmosphere causes oxidation of the sulphides and resultant cracks and disintegration. Puzzolan cement is much lighter in weight than Portland, and is usually of a light lilac color instead of the well-known bluish gray. Freshly made pats of Puzzolan will show stains instead of the even color of Portland.

The manufacture of cement in England began about the year 1791, with Parker's cement, which was produced by calcining at a temperature sufficient to liberate the carbonic acid gas, and subsequently pulverizing, the argillo-calcareous nodules found in the Isle of Sheppey, containing approximately 70% carbonate of lime, 4% oxide of iron, 18% silica and 6½% alumina. Although the first discovery of cement rock in the United States was made 87 years ago, the process of manufacturing natural hydraulic cement is to-day, excepting improvements in kilns and grinding processes, substantially the same as used by Mr. Parker. The relative growth of the natural hydraulic cement industry and of the Portland cement industry is shown by the fact that of the former there were manufactured in the United States 2,030,000 barrels in 1880 and 4,866,331 barrels in 1904, as against 82,000 barrels of the latter in 1880 and 26,505,881 barrels in 1904, showing for the 24 years last past a gain of less than 140% for the natural hydraulic cement against a gain of 32,224% for the Portland.

Another cement which deserves passing notice

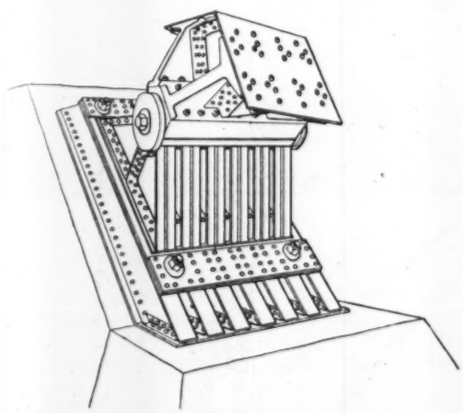


Fig. 4. Assembled Skewback Bearing of Zambesi Arch Bridge.

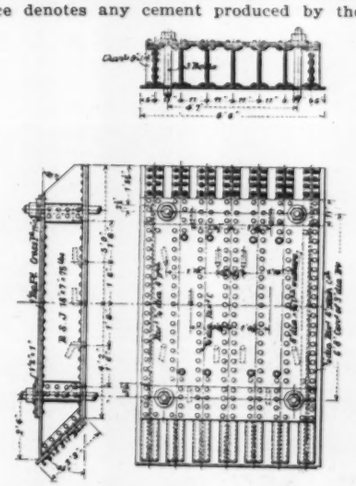


Fig. 5. Details of Skewback Base Plate.

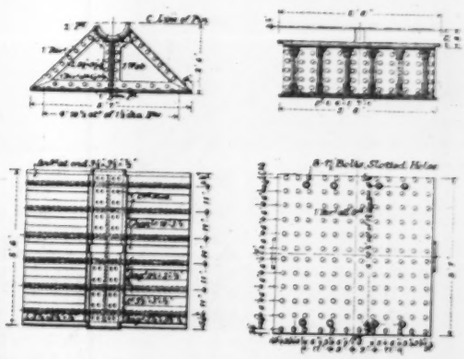


Fig. 6. Details of Skewback Pedestal.

*Copyright, 1905, by Engineering News Pub. Co.
†Secretary American Hydraulic Stone Co., Denver, Colo.

is known as silica cement. It is merely a mixture of equal parts of Portland cement and sand ground to extreme fineness. It produces good results, but is in reality an adulteration, and there is no excuse, at the present low price of cement, for its purchase. It may be detected by the sediment in the jelly remaining after pouring a little muriatic acid on a small quantity of cement.

Portland cement is produced by calcining up to incipient fusion a mixture in definite proportions of argillaceous and calcareous substances, the resulting clinker being ground to extreme fineness. It is a curious fact that this clinker is incapable of hydraulic activity before grinding, and that the hydraulicity of cement constantly increases with fineness of grinding. The name was first given to this class of cements on account of the resemblance in color to the famous Portland building stone of England. The essential elements are lime, silica and alumina. The industry was developed in Europe earlier than in America, and certain German brands have gained a world-wide reputation, though possessing no points of superiority over the American brands of the present day.

With the development of the rotary kiln, which was invented in England but perfected in the United States, a great gain was effected by placing the process of burning at all times under the direct control of the operator. Improvements in grinding machinery have similarly increased the efficiency in that department, while the relative proportions of ingredients are now carefully determined by constant chemical analysis, so that the product of an American Portland cement plant is of a very definitely known quality. In 1903 there were 78 factories in the United States making a true Portland cement. It is, therefore, evident that a wide range of choice is offered as to brands, and the concrete block manufacturer will be largely governed by location and freight rates, as the keen competition of recent years has resulted in a product so uniformly excellent that one can scarcely go amiss in buying from one of the larger companies.

In selecting a brand of known reputation one is able to profit by the exhaustive factory tests, and leave himself free to make his own tests on blocks of the finished concrete. And this is in some respects more satisfactory, for, while cement theoretically constitutes the principal element of strength in concrete, it is found in practice that the character of aggregates and the presence of deleterious substances in the sand have a very potent bearing on the ultimate strength. One should as far as possible avoid the use of different brands of cement, as greater uniformity of color is thus obtained. Prices are made on Portland cement by the barrel of 380 lbs. net, each barrel being the equivalent of four sacks of one cubic foot each. It may be procured in paper sacks or in cloth, the latter being billed at 10 cents each, and an equal credit allowed for all sacks returned in good condition to the factory. As a considerable saving in cost is made by large purchases, ample storage should be provided for a stock of cement, and precautions taken to preclude the possibility of its gathering moisture.

Sand is the next ingredient to be considered. Local availability and cost must, of course, govern to some extent. The sand should, however, be sharp, siliceous and clean. While some experimental tests have shown no loss of strength by

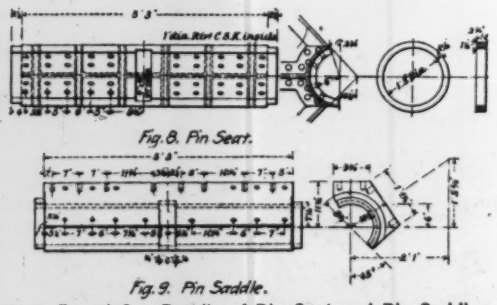


Fig. 8. Pin Seat.

Fig. 9. Pin Saddle.

Figs. 7 and 8. Details of Pin Seat and Pin Saddle.

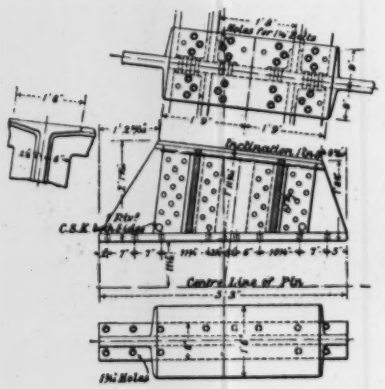
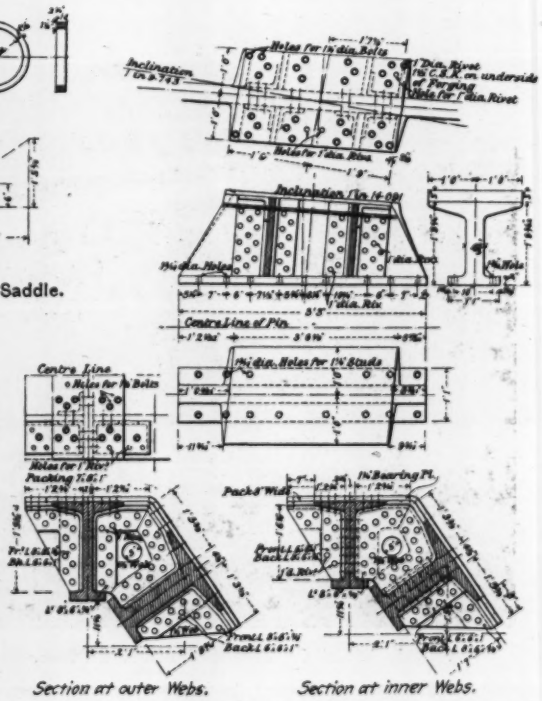
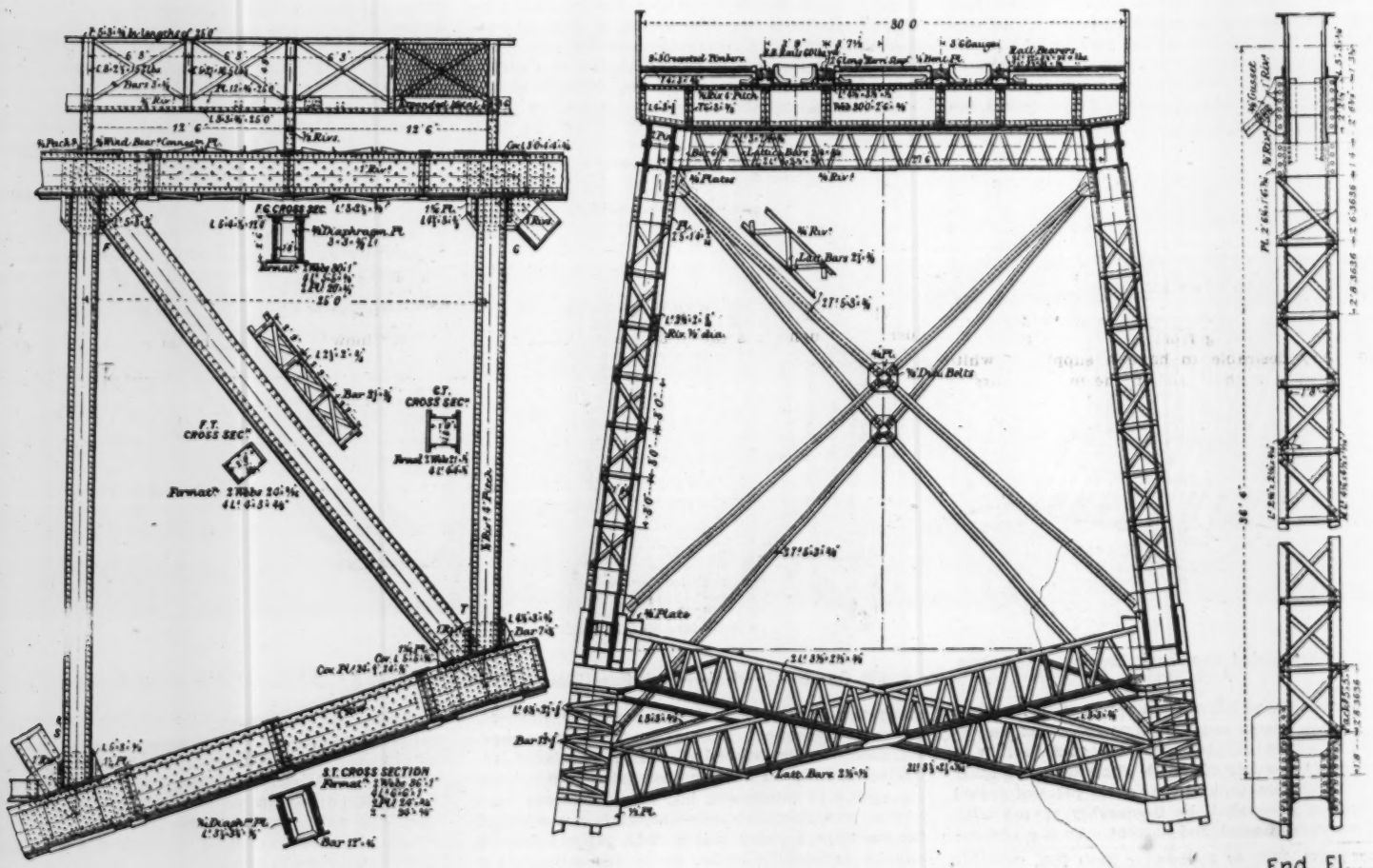


Fig. 9. Details of Saddle Pillars and Connection Plate for End Posts.



Section at outer Webs. Section at inner Webs.

Fig. 10. Details of Saddle Pillars and Connection Plates for Arch Chord.



Elevation. Cross Section. End El. of Post.

FIG. 11. TYPICAL PANEL DETAILS OF ARCH TRUSS.

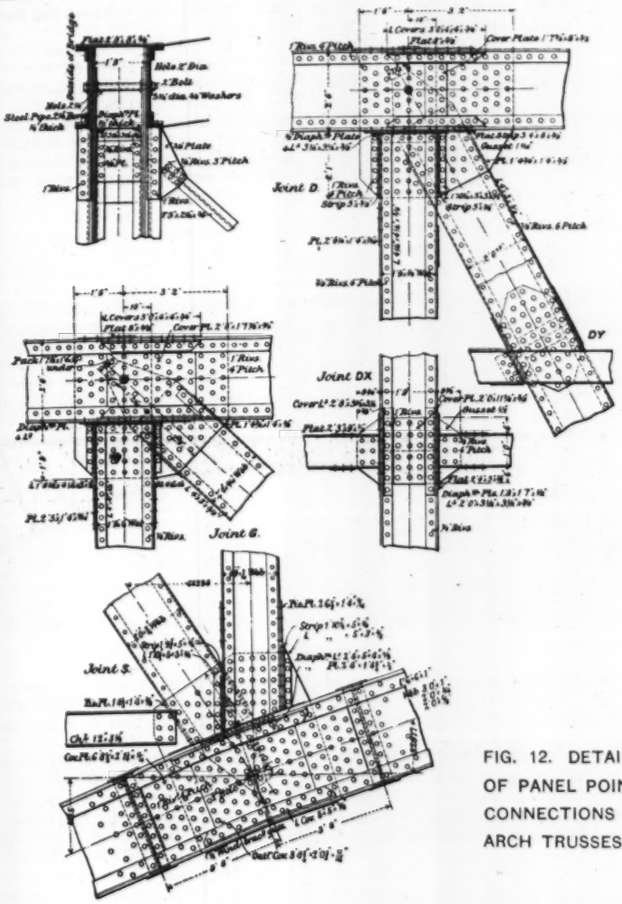


FIG. 12. DETAILS OF PANEL POINT CONNECTIONS IN ARCH TRUSSES.

an admixture of a certain percentage of clay, the best practice in building block work demands that the sand be free from loam, clay or other foreign substances. If sand cannot be obtained in its natural state without such foreign materials, thorough washing is necessary to produce a reliable block. The general rule is, that the washing should continue until clean water is no longer discolored. The sharper the sand the greater will be the strength of the block. This is not hard to understand when we consider the necessity of the cement adhering to the sand facets, and also that the increase of sharpness produces a better bond among the grains of sand.

The color of sand is worthy of consideration, as it has more to do with the color of the block than most operators realize. Where a facing is used of a texture differing from the body of the block, it is very desirable to have a supply of white sand, similar to that used in the manufacture of glass, by the use of which a most beautiful face is secured without the addition of coloring matter. The quantity of sand should have the most careful consideration, as this will determine whether the block will be weak and porous or strong and dense in structure. The greater the proportion of sand, the more cement necessary to cause adhesion of the grains, and to fill the voids in the sand, but the amount of sand must not be less than necessary to fill the voids in the gravel or broken stone. It is not supposed that the average block maker will have at hand elaborate apparatus for scientific determination of voids and porosity, and therefore his best method of arriving at the proper proportions of sand to use with a given aggregate is to pour into a vessel filled with gravel or stone a measured quantity of water. The volume of water received will closely approximate the requisite amount of sand. This is very important on account of the variation in aggregates, and it is impossible without some test of this kind to say that a given mixture will result in a dense block unless the proposed mixture be so largely sand that an abnormal amount of cement is used or the grains are not thoroughly coated.

The gravel used in concrete block manufacture should contain a fair percentage of as large sizes as can be advantageously employed in the particular style of machine in use. It is better to have the gravel run from fine to coarse as the smaller sizes will tend to fill the spaces intervening between the large sizes, thus reducing the amount of sand necessary to fill voids. For this reason bank gravel is preferable, as it will often show such a gradation of sizes as to require little admixture of sand, but like sand it must be free from foreign materials. It is always advantageous to use as great a percentage of large sizes as possible without creation of voids as by this course greater strength is obtained from a given percentage of cement.

Where gravel is not available, crushed stone is used. In such cases care must be exercised to obtain stone which will be as strong as the mortar, otherwise the concrete will be weakened by lack of strength in the aggregates. Exhaustive experiments on the relative strength of stone and gravel concrete show that at an early age the stone concrete is stronger but the gravel concrete makes a greater percentage of gain in strength with age.

Cinder concrete should not be used for walls intended to carry weight, or to be subjected to lateral stress. Brickbats and similar materials are not permissible as aggregates in any class of concrete block construction.

The water used both in mixing and in curing should be clean and as free as possible from injurious minerals or vegetable matter. The amount of water will vary under different systems of manufacture, but under all it is an item of the greatest importance, without which chemical reaction is impossible.

MIXING.

In the matter of mixing, the first question which presents itself is what proportions shall be used. While the character of local materials makes it impossible to lay down any exact rule, some general observations may be helpful. The voids in sand, gravel or broken stone will show a variation ranging from 33% to 50%. Assuming that we have to deal with the larger percentage, a mix of 1-2-4 should be used, which is classified as the lowest grade of fat mixture. With certain character of aggregates, however, a lean mixture, as 1-3-5, may be advantageously employed. On the other hand, where gravel or broken stone is not used, the proportion should be 1 to 4 of cement and sand. A fat mixture possesses greater tensile strength than a lean, but compressive strength depends upon the thorough filling of voids. Ultimate success with any mixture can only be attained by the entire coating of every grain of sand with cement and every piece of stone or gravel with the sand-cement mortar. Hence it is evident that a lean mixture may with thorough and intelligent mixing prove more satisfactory than a fat mixture with hasty and indifferent mixing.

Where necessity compels mixing by hand, a platform or cement floor should be provided and the sand spread thereon, the cement then spread on the sand and turned twice before wetting. The water should then be applied by spray from a hose nozzle while the mixture is being turned, and when the mass is sufficiently moistened and the water evenly incorporated the gravel or stone (previously wet to avoid absorption) should be spread on this mortar and the whole turned at least twice. It is a good rule to continue the mixing until an even color is obtained.

Wherever possible, however, a power mixer should be installed as the initial cost is a matter of small consideration in view of the subsequent saving of labor and the greater uniformity obtained in the mix. The most exhaustive comparative tests of hand and machine mixing of which record has been made were in connection with the construction of a pier in Duluth Harbor about five years ago. At seven days the hand-mixed concrete showed 53% of the strength of machine

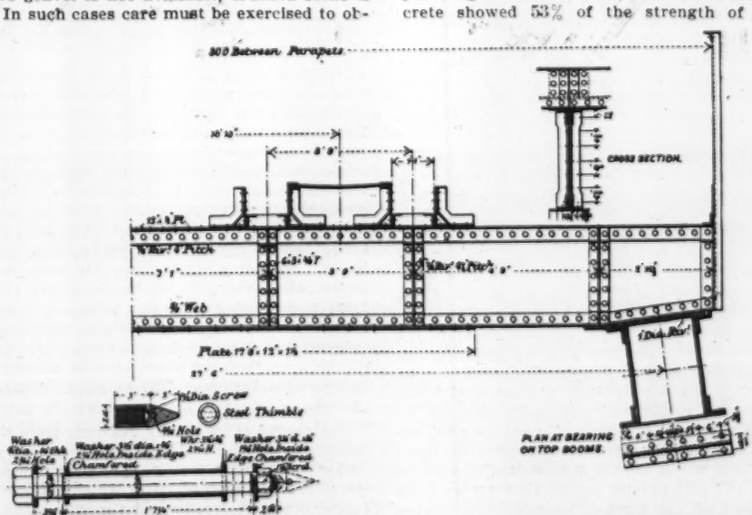


Fig. 13. Details of Assemblying Pin for Making Panel Point Connections.

Fig. 14. General Details of Floor Construction.

mixed; at 28 days 77%; at six months 84%, and at one year 87%.

There are a great many mixers on the market and it is necessary to exercise some judgment in selecting one which will thoroughly mix the ingredients and do it quickly and cheaply. The usual type of continuous mixer is not so well adapted to concrete block manufacture as are the batch mixers. It is very important, either in hand or machine mixing, to regulate the size of batches mixed so that no concrete shall be used which has been wet over half an hour, as cements usually take their initial set within 30 or 40 minutes after the addition of water, and if incorporated into blocks thereafter a certain portion of strength is lost.

The amount of water used in mixing is subject to the greatest variation, depending upon the style of machine used. A dry mixture is one in

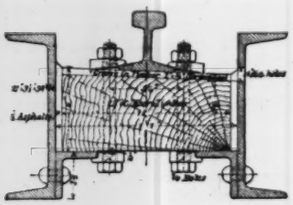


Fig. 16. Enlarged Detail of Rail Support.

which just enough water is used to hold the cement and sand together. When compressed in the hand it will retain its shape, but will show no water and will not discolor the hand. A medium mixture is one in which water enough is used to flush to the surface when slightly tamped or compressed. A wet mixture is one in which an excess of water is used, the concrete being in a more or less fluid condition. It will be seen that machines have been designed for using these different mixtures and the manufacturers of these various machines adhere with great tenacity to the particular degree of moisture required to obtain the best results under their respective methods of manufacture. Tests show, in a general way, that a dry mix has its greatest relative strength on short time tests while the use of a greater percentage of water increases the relative increase in strength with age. In the process of concrete block making a certain amount of water is absolutely essential to secure proper crystallization of the silicates and if it is not used in the mixture it must be supplied subsequently. Whatever method be used it is essential that the proportion of water be uniform, as the making of one batch wet and another dry will produce an unsightly variation in the color of the blocks.

Before leaving the subject of mixing, I wish to more fully impress upon the reader the importance of the most thorough manipulation of the mass. We have already seen that it is only by this method that voids can be eliminated and the greatest strength obtained. There are, however, other advantages resulting from an absence of porosity. The permeability of a concrete block is greatly reduced by added density and with sufficient attention to this matter the question of waterproofing is, at least in a measure, solved. Efflorescence is also practically overcome by making really dense and reasonably impervious blocks.

MANUFACTURE.

Our materials having been selected, our proportions having been determined, our mixture having been made, we are now ready for the actual manufacturing of concrete blocks. The processes which are offered for our consideration are three in number: Tamping, pressing and pouring.

The first is the method generally used in connection with the dry mixture, the material being shoveled into molds and gradually rammed to place as the mold is filling. To secure good results it is necessary that the tamping be thoroughly done, which involes a considerable amount of labor. Of late several automatic tampers have been placed on the market, calculated to lighten the labor, secure greater rapidity in manufacture and insure a more uniform product. Tamping is better adapted to a dry mixture, as it will pack under the blows of the temper and will not become displaced by lateral pressure as is the case if a medium or wet mixture be used under a tamper. This method is also more satisfactory with a cement and sand mixture than with coarser aggregates as gravel or broken stone, unless comparatively small in size, does not readily yield the best results either in a dry mixture or under tamping. It may, therefore, be set down as a general rule that under tamped processes a dry mixture and aggregates of small size should be employed.

Under the systems using compression the advantage is claimed that a more uniform density is secured by the simultaneous application of pressure to all parts of the block. As the mold is entirely filled before the application of this pressure, the necessity for a dry mixture and fine

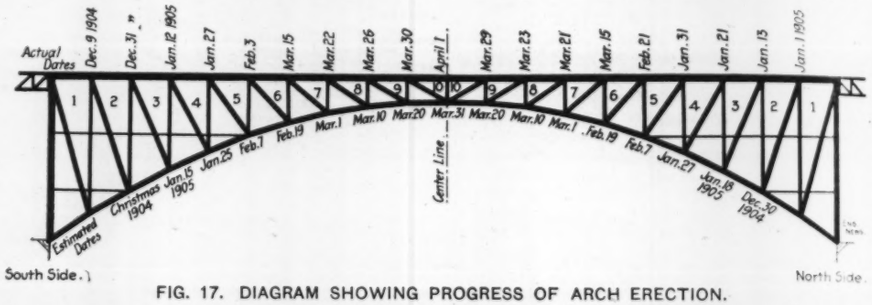


FIG. 17. DIAGRAM SHOWING PROGRESS OF ARCH ERECTION.

aggregates is overcome, and a medium mixture is ordinarily employed containing aggregates of a size as large as can be conveniently accommodated in the particular mold in use.

The plan of operation under the poured processes is radically different from either of the others, as neither tamping or pressure is relied upon to compact the mass and bring the aggregates so close together as to secure necessary adhesion. Reliance is rather had upon the reduction of the cement to a fluid state, it being contended that by this method the aggregates are more thoroughly coated and perfect crystallization assured. An honest objection to this process appears to lie in the fact that the greater specific gravity of the cement is liable to cause it to settle to the bottom of the mold, and a practical difficulty is the large number of molds necessary on account of the length of time required for such a block to attain sufficient rigidity to be removed from the mold.

It is to be presumed that any one about to engage in the manufacture of concrete building blocks will provide himself with some one of the large number of machines now offered to the public, which are roughly devisable into five classes:

1. Upright machines for making hollow blocks.
2. Machines for making hollow blocks on the side.
3. Machines for making staggered blocks.
4. Machines operated by the wet process.
5. Machines making blocks for two-piece walls.

The first class of machine is, I take it, well known to most readers. The machines consist of removable hinged sides and upright interior cores. The blocks are made by tamping under the dry process and are, in the earlier designs of machines, removed on iron pallets, while some of the later machines avoid this expense by turning the mold over and releasing the block on wood or in some cases by making the block on a wooden board and lifting the mold bodily away from the block. The cores are in many machines mechanically raised and lowered, but in others the cores remain stationary while the bottom and sides are adjustable by various mechanical devices. It is evident that these variations have little influence on the manufactured block, and are merely labor-saving contrivances. The principle involved in the manufacture is in every case the same.

The second class is only different from the first in so far as the mold is turned on its side in order to facilitate facing. The face matter is first deposited and tamped, after which the cores slide into the mold laterally and the filling and tamping proceeds. The only thing gained over the first class is the opportunity to use a face mixture of different composition from the body of the block.

The third class eliminates the straight cross-partitions of the first and second classes and so disposes the cores that a staggered effect is produced. The object is to prevent the passage of moisture through the wall. This class of blocks have not been long on the market but seem to be meeting with considerable success, and are apparently an improvement as to the purpose they aim to accomplish.

The fourth class is totally different from others in process. They use a large number of light iron molds, having interior cores, and usually constructed to admit a circulation of air in the walls by making the body of the block of a less height and length than the faces. Into these molds the wet mixture previously described is poured and allowed to stand for several hours. The principal contentions of manufacturers of these molds are that the blocks are waterproof; that they are actual stone, and that they are cheaply made.

Class five is a radical departure from the others. Two-piece walls were brought out about three years ago and have distinctive features worthy of consideration. They are manufactured by pressure of a medium mixture, usually containing a considerable portion of large aggregates. This mixture is shoveled into the mold, pressed almost instantaneously, and forthwith released from the mold. Where it is desired to use a face mixture of color or texture other than the concrete forming the body of the block, a gage is used to rake out a quarter or three-eighths of an inch of the coarse concrete before it is pressed, and the face matter is applied on this loose mass and all pressed at one time. This bonds the face and body of the block very firmly together and as the pressure is applied directly to the face of the block a beautiful face of great hardness and density is obtained. This method of manufacture is made possible by the shape of the block, which consists of a face section with a long right-angle arm extending inwardly from the middle and a shorter arm extending from each end. In laying the blocks in a wall no portion of a block extends through the wall and, indeed, by leaving the interior vertical joints open to afford a free circulation of air no portion of a block on one side of the wall comes in contact with any block from the opposite side thus precluding the passage of moisture and producing in effect two walls, tied by the overlapping of arms or webs in alternate courses, and affording a great resistance to lateral stress by the employment of the principle of bonding known as the header and stretcher bond of brick work or the three-quarter stone of ordinary masonry, while in thin partition walls the bonding is by the system of through-stones.

CURING.

While the importance of curing leads us to consider it under a separate heading, it is well to understand distinctly that curing is a most important part of the manufacturing process. It is in the adaptability for effective and thorough curing that block construction differs essentially from all other systems of concrete construction, and therein does it possess a distinct advantage. It is, however, necessary that the importance of curing be firmly impressed upon the block maker and every effort made to secure the best results. I believe that to a failure to appreciate the advantages of scientific curing is due, more than to any other cause, the difficulties encountered by many manufacturers. To secure strength and durability in concrete blocks it is necessary that

the cement shall have a certain amount of water to produce the chemical reactions resulting in crystallization of the silicates of lime and aluminum. If the requisite amount of water be not used in the initial mixing it is evident that it must be subsequently supplied. However, this application of moisture is often made in a manner so irregular and haphazard that the cement is allowed to take its final set under the most unfavorable conditions and as a consequence a great portion of its strength is lost.

The great point to be remembered is that uniform conditions must be maintained. If a block be wet in the morning, dry at noon and wet again at night it is not hard to see why it will lack strength when tested. Again, it is essential that every part of the block shall have the same treatment. Varying degrees of moisture or exposure to the sun will cause variation in contraction and result in cracks and liability to subsequent disintegration, as well as variation in color. It is, therefore, essential that the blocks be sprinkled at regular intervals, and so frequently that there is no drying. The blocks should not, during curing, be allowed to become dry enough to begin to turn white. The sprinkling should be thorough, evenly reaching every part of the block and should be accomplished by use of a gentle spray which will not deface the freshly made blocks. Moreover, the blocks must be protected from the sun to secure necessary uniformity of conditions. A free circulation of air among the blocks is desirable, and it is bad practice to allow blocks to rest in contact with one another in the curing shed. Most manufacturers are anxious to make a record as to speed and cost, and rush blocks into a wall while too green. The result is that the exposed side of the wall dries more rapidly than the interior and the part which should possess the greater strength becomes the weaker and may disintegrate in a few years.

Blocks made by the dry process should have the most careful curing for at least twenty days after coming from the molds, while from a week to ten days of similar treatment will suffice for blocks made from a medium mixture. Blocks made by the wet process contain an excess of water which is subsequently taken up by the cement so that they will require little water in curing except on exposed surfaces, but the maintenance of uniform conditions and shelter from the sun is quite as important as under either of the other processes.

The curing of blocks in winter has been successfully conducted by protection from freezing for the first few days. As soon as the block acquires sufficient rigidity to protect itself from the danger of expansion cracks freezing merely suspends the setting but does not prevent its resumption upon a rise in temperature. However, curing under these conditions requires more time and a constant exercise of the greatest caution.

In view of the fact that crystallization is quickened by a rise in temperature experiments have been made on curing blocks in a live steam room. The results have been very satisfactory as to time, making it possible to lay blocks in the wall within 48 hours after molding. It is still an unsettled question, however, as to how great an extent this artificial acceleration of the chemical reaction secures the full strength of the cement.

FACING.

Authorities differ as to the advisability of applying a thin facing of different composition from the material composing the body of the block. As the manufacture of concrete blocks sprang from monolithic construction, it is believed that the opposition to facing originated from the bad results obtained by efforts made to face that class of work. The cause of those ill effects is, however, not difficult to determine when one considers that in such construction the coarse concrete is deposited in forms and allowed to set for some time before the removal of those forms, and that the face matter is afterward applied and the surface troweled. This process is wrong for two reasons: First, the backing having already taken its set does not, even though thoroughly wet, allow ready adhesion of the facing which is, therefore, liable to separation and cracking. Second, the troweling draws the neat cement to the surface and results in hair cracks owing to the variation in contraction. The fact that very many of the machines now on the market advertise facility of facing as a strong point in favor of their process indicates that facing is growing in favor, and it is certain that the efforts made by the various manufacturers to satisfactorily solve this problem have resulted in greater success than was generally anticipated. It will, therefore, be well to consider some points in connection with methods calculated to secure the greatest efficiency in this line.

The objects of facing are three:

1. Saving in cost of material.
2. Securing a beautiful surface.
3. Making the surface more dense and impervious.

The saving in material is effected by using a coarse lean mixture for the body of the block and applying a face of fine fat mixture varying from a quarter to a half inch in thickness. The beauty of surface results from the opportunity afforded of using expensive selected material for this thin face which would make the cost prohibitive if used throughout the entire block. The use of the fat mixture with the fine aggregate makes it possible to produce a face which is practically impermeable and possesses much greater density than the mixture ordinarily employed for the body of the block.

The selection of sand for the face mixture is worthy of most careful consideration, and here we are not dependent upon local availability as the small quantity required warrants shipping from a considerable distance to ensure the desired result. As mentioned in a previous section, a fine white sand of such sharpness as used in glass factories is suitable, and sharp screenings from crushed granite also afford an excellent material.

The face mixture may be made in proportions varying from 1-1 to 1-3 and requires greater care in mixing than concrete, as there is a tendency to roll up and become lumpy, which may be overcome by screening the wet mixture immediately before use. The best results are obtained by using a little more water than usual in the body of the block and applying the face matter in about the consistency of an ordinary dry mix; the face will then, by capillary attraction, draw moisture from the body of the block. It will be noted that the process is, in this respect, directly opposite to the method ordinarily used in sidewalk construction.

Whether the block be made by tamping or pressure, it should be so arranged that direct compression of the face is obtained and there must be no interval of time between the manufacture of the face and body of the block, but both must be made at one simultaneous operation, so that the face matter may be thoroughly imbedded into the loose coarse concrete and become an integral part of the block with no distinct line of cleavage between the two. It is only thus that separation and cracks may be avoided and a product of great durability assured.

Many block makers produce desired colors by mixing dry colors with the face matter. Only mineral colors should be used, free from deleterious chemicals, acids or greases. As several manufacturers are now offering a variety of colors especially prepared with a view to obviate the loss of strength frequently resulting from an admixture of coloring matter, and as these specially prepared colors have given general satisfaction it is well to procure them and avoid the expense and annoyance incident to experimentation along original lines of coloring. These colors are thoroughly mixed with the dry facing sand before the cement is added, and used in such proportions that a freshly made block will be two shades darker than required when cured.

The form of face is a matter which is given much attention by the manufacturers of concrete block machines. Those in most common use are smooth lace, bevel edge, corrugated or ribbed, pitch or rock face, and special designs of ornamental faces. In the use of various designs of these face plates it is desirable, at all times, to bear clearly in mind the fact that concrete blocks have a place of their own in building construction, that they are capable of such artistic finish that they may rest upon the merit of their own beauty, and that they are not dependent for their popularity upon imitation of any other material commonly used in the construction of buildings. It is to this idea of imitation which has been so prevalent in the earlier stages of the development of this industry, and to the consequent failure to appreciate the artistic possibilities of concrete block construction, that much that is monotonous, much that is artificial, much that is unpleasing and abhorrent in concrete block architecture is chargeable.

TESTING.

It is very desirable that tests of tensile and compressive strength be made from time to time. While the customary method of testing cement briquettes is useful, it gives us no information concerning the strength-giving properties of the other materials used, and it was found in a series of tests recently conducted at the University of Michigan that the character of sand, gravel or broken stone, the presence of earthly matter, the use of an excessive amount of sand, the size of aggregates and the thoroughness of mixing, all have an important bearing upon the strength of the finished block. A block for testing should be not less than 28 days old, and to ascertain the relative tensile strength should be supported by knife edges upon the platen of the testing press with the load resting upon the center of the block. Compression tests may afterward be made upon fragments of the same block.

COST.

Too much has been written about the low cost of concrete blocks. While they may be placed in the wall at a lower cost than any natural material of equal quality, yet the distinctive points of excellence peculiar to concrete block construction are of far greater moment than the saving in cost. Many block makers have considered low cost the chief end to be attained and have sacrificed quality to its attainment, while the highest success can only be secured by those who make uniformly superior blocks and keep the cost down by intelligent management and judicious systematization of the work of manufacturing. The literature of every manufacturer of concrete block machines contain statements of cost, and these figures may be considered as truthfully compiled from the results of work intelligently conducted under favorable conditions. A paper read at a recent meeting of the Iowa Cement Users contains a rather full report as to cost, being compiled from reports obtained from a large number of block makers. The results were computed to ascertain the average cost per square foot of 10-in. wall, and were as follows:

Sand	2 cts.
Cement	4.5 "
Labor (manufacture and curing)	3.8 "
Total	10.3 "

For 8-in. walls, 1 ct. less.
For 12-in. walls, 1⅔ cts. more.

The cost of labor and mortar for laying averaged five cents per foot. The above figures do not take into consideration the cost of administration or incidentals.

CONSTRUCTION.

In laying blocks in a wall it is necessary that they be first thoroughly moistened to prevent absorption of water from the mortar and consequent insufficiency of adhesion. The best mortar for laying concrete blocks is composed of one part cement, three sand and one slaked lime. The admixture of this proportion of lime increases the adhesiveness and gives to the mortar a body which makes it trowel with greater facility. To produce satisfactory results it is necessary that joints be uniform. Usually a quarter inch joint will produce the best effect.

The size of blocks varies greatly with the different machines and processes and it would seem, as suggested at the June meeting of the Concrete Block Machine Manufacturers' Association, that the public good might be greatly subserved by the exercise of a spirit of co-operation looking toward the adoption of more universal standards of sizes. There is no apparent reason why the size of concrete blocks should not be as standard as the size of brick. What this size should be is not material so long as symmetrical proportions are maintained between the width and length by observing the rule of multiples. Whatever size may ultimately be adopted should have allowance made for width of mortar joints so that the block when laid in the wall will, with its mortar joint, be of the determined dimensions.

Until such action shall be taken it is imprac-

ticable to prepare any extensive sets of plans for the construction of concrete buildings. The only important respect in which such plans would differ from those for buildings of other materials would be in the adaptation of dimensions to the size of the blocks and the placing of openings in conformity thereto, but with the present diversity of sizes a series of plans adapted to the product of one machine would be no better suited to the product of another than would the plan of an ordinary brick house.

A few manufacturers provide machines for making sills and lintels of four and five feet lengths, but it is not practicable to construct machines along present lines for the larger sizes so often required, and it may be fairly said that in general the block maker is thrown upon his own resources for the construction of these parts of a building. Some simple reinforcement may be used and these parts easily and quickly constructed in wooden molds made in any block factory. The customary method of troweling the surface has been the cause of most of the trouble in making sills and lintels. As previously mentioned this troweling causes checks and hair cracks, rendering the work unsightly and liable to weather badly. This trouble is eliminated by constructing a knock-down mold (clamped at the ends) of the best straight-grained surfaced lumber, putting in the face matter first and backing with coarse concrete, the latter as wet as practicable. Of course it has often been observed that faced work constructed in lumber forms shows the grain of the wood. To obviate this the interior surfaces of the mold and bottom board should be carefully sandpapered and shellaced.

Of the various methods used by different systems for supporting floor joists the use of steel joist hangers is undoubtedly superior. It not only permits of the unbroken construction of the wall but also possesses a distinct advantage in as much as the floors are entirely free from the walls, so that the burning of the former will not cause the latter to fall.

As it is impossible to drive nails into concrete, it becomes necessary to provide some means for fastening door and window trim, base boards, picture molding, etc. This is best accomplished by the use of a very excellent metal wall plug now on the market which is laid in the mortar joints as the wall is building.

There is no reason in the nature of things why plastering should not be applied directly to the interior of a wall built of concrete blocks. Indeed, if the wall be regularly laid and the interior unfaced the surface is such that the priming coats may be omitted and a coat of hard plaster applied directly to the blocks. One must, however, be sure either that the blocks are waterproof or that the construction of the wall is such as to prevent the passage of moisture. Without the presence of one or the other of these safeguards, furring and lath are as necessary as with ordinary solid brick walls.

Not only may the superstructure be of concrete blocks, but the foundation as well; the latter should be of a little heavier wall and should rest upon concrete footing the depth of which must be determined by the character of the soil and the width by the load which the ground will sustain without deflection. It is very important that these matters be definitely ascertained and a considerable factor of safety allowed inasmuch as any settlement will result in cracked walls.

The widths of walls considered necessary for ordinary buildings by the best authorities on concrete block construction are approximately as follows:

For one-story buildings	8-in. walls.
For two-story buildings	10-in. "
For three-story buildings,	12-in. and 10-in. "
For four-story buildings,	15, 12 and 10-in. "

In some cities the Department for Inspection of Buildings have granted permits without question for constructing walls of the widths mentioned. In other places rival interests have caused to be passed ordinances prejudicial to the concrete block industry. Such opposition is necessarily short-lived providing block makers use diligence in universally maintaining that high standard of excellence of which the industry is easily capable.

The matter of fireproofing of buildings is probably now receiving greater attention than at any previous time in the world's history. The attention of architects and insurance experts was actively drawn to concrete construction by the great fire-resisting qualities manifested in the Baltimore conflagration and in numerous fires of more recent date, and the interest thus aroused has led to a number of experimental fires the results of which prove beyond a doubt that well-made concrete is not merely non-inflammable but that it withstands the conflagration test far better than any other building material in use at the present day. It is generally considered that concrete will disintegrate under the same extremes of temperature, or the same alternate subjection to fire and water, that would cause decomposition in the stone composing the aggregate. This view is erroneous inasmuch as the aggregates in properly made concrete are protected by the surrounding matrix, and the latter resists fire far better than any stone, granite not excepted. Here, then, we see the prime importance of obeying the law mentioned in the first section of this paper: Let every grain of sand be thoroughly coated with cement, and let every piece of gravel or stone be thoroughly coated with the sand-cement mortar.

THE ACTION OF CAPPED ARMOR-PIERCING SHELL.*

By Eugen Kodar v. Thurnwerth.

Among the most notable of the recent achievements in artillery, especially in connection with the effect of the projectile on the target, is the increased penetration that has been attained with armor-piercing shell by the application of a cap to the projectile. It is proposed in the following paper to examine briefly the reasons for this superiority of the capped projectile, on the basis of tests made with a variety of plates.

There has been waging an incessant contest between armor and artillery since the fifties of the last century, when wrought iron plates were first used as armor, which kept out completely the cast-iron balls of the smooth-bores of the period. In this struggle of armor against artillery, now one and now the other has been ahead, and despite the fact that the dead material seems to have been worked to its utmost limit, there does not yet appear to have been any pause in the competition. Each year brings its improvements and its surprises.

The latest achievement in the domain of armor was the general introduction, since 1890, of Krupp cemented and hardened nickel-chrome steel; with this step, armor apparently rendered nugatory the action of the projectile. Though good K.C. plates were not inpenetrable to a good projectile of corresponding size, yet the inevitable shattering of the projectile seriously reduced its effect, or made it altogether ineffectual. But the armor-plate did not hold its victory long; hardly three years had elapsed after the astonishing results of these armor tests were known, before there appeared the still more wonderful news of the action of capped projectiles, whose overwhelming attack defeated the strongest Krupp plates. So with the general introduction of capped projectiles, the artillery has acquired a superiority, within certain limits, until something further develops.

The relative superiority of armor or projectile is generally determined by the fact whether plates as thick as the caliber of the projectile can or cannot be penetrated at short fighting ranges. For example, a 15-cm. (6-in.) armor-piercing shell weighing 45.5 kg. (100 lbs.) cannot pierce a 150 mm. (6-in.) K. C. plate at 500 m. (550 yds.); but this shell would penetrate with ease a plate of equal thickness of unhardened nickel-steel even at 3,000 m. (3,300 yds.). In the former case we speak of the armor as superior to the projectile, in the latter case of the projectile as superior to the armor. With this standard, capped projectiles are superior to the best armor-plate, for at short ranges with correspondingly large striking velocity they penetrate plates of 1½ and even 2 calibers thickness. The literature on this projectile, which is now used in nearly all countries, is fairly copious, and most of the writers are agreed that at present adequate protection against this projectile must be sought by increasing the thickness of the armor, or in increasing the fighting ranges. The reasons for the superiority of the capped projectile over the uncapped are often not discussed at all, generally they are touched upon in a superficial way, and the explanations offered fail to satisfy the requirements of even an elementary theory.

Perhaps the most widespread explanation is, that the material of the cap acts as a lubricant for the projectile in its passage through the plate, and reduces the great amount of friction that occurs between the surface of the projectile and the plate opening. Were it indeed true that the action of the cap lay in nothing else than this, the advantage would hold only in the case of soft plates, where the head and body of the projectile both come into sliding contact with the plate opening, and an advantage would not be found with hard plates where there is not sliding contact between plate and projectile. Now all experiments show that the superiority of the capped projectile is unquestionable only with hardened plates, whereas with soft plates the capped projectile is not better than the uncapped.

Against the hypothesis that the cap serves as a lubricant, there also stands the consideration of the great quantity of energy that would have to be spent in heating and melting the cap, which energy being drawn from

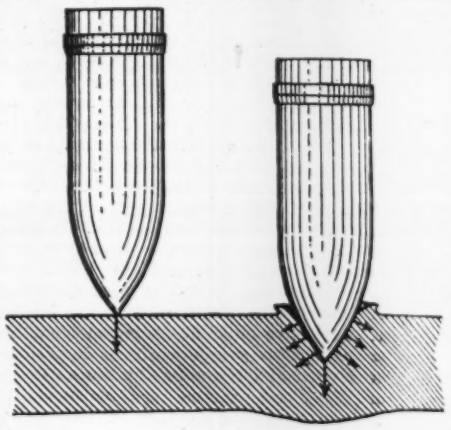


Fig. 1.

the projectile would be lost for its especial work of penetration. In the tests of the Royal Naval Committee (Austrian) the weight of a cap of a 12-cm. armor-piercing shell (4.7-in.) was about 1.5 kg. (3.3 lbs.). To heat this mass to the melting point would require 1.5 × 0.1165 × 1,400 or 245 calories, and to effect the melting itself would require about 50 calories more; this would be equivalent to a loss of energy of about 124 meter-ton. Yet in some of the tests capped projectiles with about 376 m.t. striking energy have not only gone clean through the plate attacked, but have gone through a butt 4 m. thick and traveled 300 or 400 m. beyond. This result would be simply impossible if 33% of the striking energy were consumed in melting the cap. Uncapped projectiles fired under like conditions broke into fragments against the plate in spite of the fact of having to their advantage this 33% of energy.

It must be admitted that around the point of impact very remarkable heating effects are often noticeable the vicinity of the opening in the plate and the shell fragments showing yellow to blue tempering colors. This points to a heating up to 300° C., but this is a good ways from a melting point of 1,400° C.

A second widely accepted hypothesis holds that the cap takes up the first shock that occurs on the impact of the

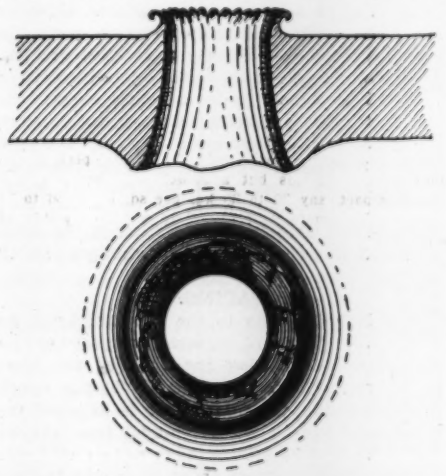


Fig. 2.

projectile, pretty much in the same way as a buffer of a railway car takes up the blow when one car meets another. In more precise terms this theory would run: The cap takes up that amount of energy which would cause the destruction of the projectile, and lets free only that part which is necessary to penetrate. But this leaves out of account the relation between the weight of the projectile and the weight of the cap, and in view of the great amount of energy present, this omission cannot be justified. By the theory of strains the cap could take up but a small amount of energy, still further reduced on account of the inferior material of the cap compared with that of the projectile, without having its molecular struc-

*Translated from the German as published in "Mitteilungen aus dem Gebiete des Seewesens," Vol. 23, No. 2, Pola, 1905, by Capt. George Blakely, Artillery Corps, U. S. A., and printed in the "Journal of the United States Artillery" for May-June, 1905.

ture destroyed. Yet it is just in connection with great energy and high velocity that capped projectiles are most effective.

Another explanation is connected with the following illustration: A needle cannot be thrust through a board without deformation. Yet if the needle is first set in a cork stopper so that it cannot bend, this can easily be accomplished.

Now the small lump of metal on the end of the projectile cannot be regarded as the guide of the shot, especially

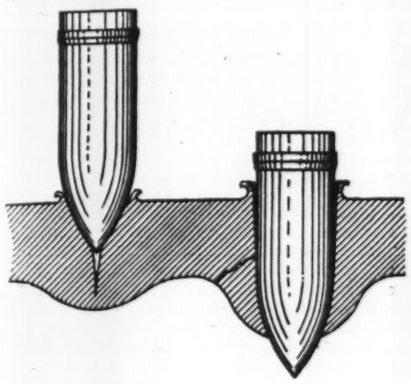


Fig. 3.

because, as we shall soon see, it has become completely deformed when the projectile stands most in need of guidance, that is when its point is piercing the hard armor-plate.

The theory that the uppermost layer of the armor is softened and the plate so transformed into a homogeneous steel plate has very much more probability than any of the explanations so far adduced. It is very likely that a molecular change does take place in the plate under the combined influence of the great temperature and the violent concussion of impact. The only question is whether the short space of time is adequate for such a change.

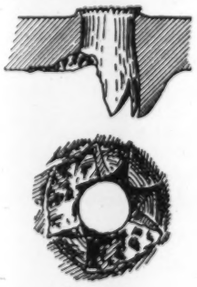


Fig. 4.

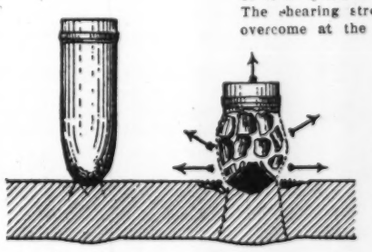


Fig. 5.

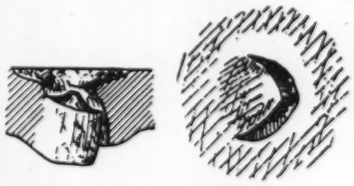


Fig. 6.

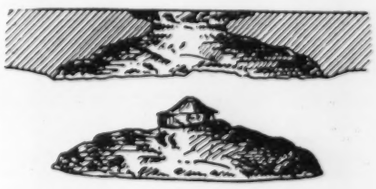


Fig. 7.

To obtain now an explanation that avoids all these defects, and accounts for the superiority of the capped projectile in a purely mechanical way, let us proceed inductively, and figure in our mind the separate phases that occur during the penetration of various kinds of armor by hardened projectiles. Right here we shall see the essential difference that characterizes the penetration of hard and soft plates. With very soft plates, like wrought-iron, it needs but a moderate pressure at the point of impact, say 30 to 35 kg. per sq. mm. (96 to 77 lbs.), before the material of the plate begins to yield and flow aside, while the point of the projectile forces its way into the plate like a chisel. The iron thus under pressure moves of course in the line of least resistance, and thus there is formed on the front of the plate by the pushing up of the material very peculiarly characteristic curls and elevations, and at the same time a bulging occurs on the back of the plate. The pressure of the point in the canal that is forming keeps growing, without passing beyond the limit of tenacity of the projectile and so without deforming it, until the point breaks through the plate, when the pressure quickly drops to zero, which it reaches when the point and ogival head of the projectile clear the plate. By the action of the projectile's head lateral motions are imparted to small masses and so the canal is widened, and on the back of the plate there is a considerable puffing up of the plate without any actual loss of material. The form of perforation shown in Fig. 2 indicates little hardness in the plate but great tenacity.

Homogeneous soft steel or unhardened nickel-steel behaves somewhat differently. In the first instant the same phenomena are observed as in the case of wrought-iron, with curling elevations on the front of the plate. But since the tenacity of steel is less than that of wrought-

During this process whic hoccupies an extremely short iron, radial cracks and fissures will occur on the back of the plate, and instead of a projecting collar there, we will find a rim of pyramidal-shaped teeth, some of which break off and are flung about, so that the back of the plate will present a broken surface more or less circular in shape surrounding the orifice made by the projectile.

The behavior of the best K. C. plates is radically different. Since the resistance to penetration is very much greater than is the case with unhardened plates, the projectile is arrested in its motion almost instantaneously, so that an enormous pressure occurs on the head of the projectile (not less than 100 to 200 kg. per sq. mm. (220 to 440 lbs.), which the best material and the most careful hardening cannot withstand. Hence at the instant of impact the head of the projectile is deformed, and the broad rounded surface that the front of the projectile now presents seeks to compress the material of the plate, since piercing is out of the question on account of the broader dimensions of the front due to the upsetting of the point. The result is that the front surface of the plate is pressed in, and of course the rear side bulges out.

During the process which occupies an extremely short time, the cylindrical body of the projectile continues its forward motion, until, arrested by the deformed head and the plate, the low tenacity of the tempered material is overcome and the projectile breaks up. The head of the projectile, broken loose by the resistance it has met, adheres with great force to the plate and is so to speak welded to it. The mushroom form that the head assumes is characteristic of this phase, the stem of the mushroom being bounded by the hollow interior of the projectile. In Fig. 5 the formation of this mushroom head is very noticeable. If the energy of impact is small, the plate will be able to keep out the projectile without further injury, that is, by its elasticity it will take up the energy that remains after the shattering of the shot and the heating of the place of striking. The effect of the projectile ceases then with the process we have described, the plate completely shutting out the projectile.

If the energy of impact is relatively large there is a portion of it transferred to the plate sufficient to effect an opening or to cause perforation. The process that then takes place can be readily explained on the basis of the law that governs the action of imperfectly elastic bodies.

The head already deformed in the previous phase becomes now the vehicle for the transference of a portion of the striking energy, and presses like a punch on a surface of greater or less extent, pushing out from in front of it a cylindrical portion of the plate like a stopper. The shearing strength of the material of the plate is overcome at the surface of this stopper, without any actual piercing of the projectile into the material. As a final result the plate is either completely perforated, or if the stopper of metal punched out from the plate holds to the plate by a portion of its surface, the plate is said to be simply opened. In this way there arises on the back of the plate the characteristic form represented in Fig. 6.

In any case whether the plate is perforated or not, the projectile breaks up into a great many very small pieces. This occurs to all projectiles, including those of the best quality, so that behind the plate even after complete perforation, are to be found but fragments of the projectile and of the metal forced out from the plate.

This manner of penetration is as characteristic for hard plates as that previously described is for soft ones. When plate-thickness and caliber agree approximately, there is practically never any other phenomena to be observed than that indicated. If this is not the case, that is, if the caliber of the projectile is considerably greater than the thickness of the plate, as for example a 24-cm. (9.4-in.) projectile against a 100-mm. (6.3-in.) plate, the shock is so great that a large piece of the plate simply breaks off. On the front of the plate is to be seen an irregular cracking, and on the rear a large concave surface. But even in this case, the head of the projectile is deformed and welded with the plate, and the projectile is shattered into a thousand small fragments.

It is obvious of course that these phenomena are beyond our control. Aside from the fact that it would be extremely dangerous to observe the penetration of a plate in close proximity, the time occupied is so infinitesimally small, that the preservation of a record of the separate phases of the process, as by photography, is out of the question. Hence all of these explanations are but hypotheses, but a certain probability is not to be denied them, for they are deduced from actual experiments, and new tests always confirm them. The explanation of the action of capped projectiles that follows, possesses also but a hypothetical value, yet it fits so close to what has gone before, that a preference may also be given to it, in view of the defects in the theories that I have before referred to.

We have seen that the action of the projectile against hard plates is unsatisfactory because the great pressure per square inch that is brought to bear on the point causes the breaking up of the projectile. A certain amount of flattening of the head from this point of view should be looked upon as advantageous, for the greater the surface that bears the pressure, the less pressure is there per unit of surface. Tests that have been made, however, show that on account of the increased difficulty of penetration, a flat headed projectile does not give better results than a pointed one. Hence the construction of capped projectiles has been resorted to, for this diminishes the pressure on the unit surface, while at the same time the advantage of a point in the penetration of the plate is not surrendered.

The superior action of the capped projectiles rests therefore on the fact that the point of the projectile is not deformed at the first instant of impact with the plate. Due to the presence of the cap, the pressure is not confined simply to the point, but is distributed uniformly over a fairly large cross-section. The unit pressure therefore does not exceed the limit above which the choice tempered material of the projectile would be impaired. As a consequence the point is not deformed at the first instant of impact but pierces like a chisel into the hard layers. This work will be so much the easier for the projectile, since the "material cone"* formed in the plate due to the cap will already have begun the destruction of the outside diamond-hard surface layer of the plate, which is not more than a few millimeters thick.

At this stage the cap has already fulfilled its mission, and the projectile goes on its way through the plate alone and uninjured. The following process now occurs:

The point having once entered the exterior hard layer, forms a path for itself in this portion of the plate by its ever-widening head forcing aside the particles in its front, their cohesion having been already disturbed by the formation of the "material cone." On the front of the plate there is a crumbling characteristic of hard metal. Where the hard metal layers pass into the softer ones this crumbling no longer occurs on account of the greater tenacity of the latter. The perforation now narrows to dimensions not much greater than the caliber of the projectile. It might be thought that the further progress of the projectile would resemble the perforation of soft homogeneous steel plates. This however is not the case, for the quantities of steel intended for hardening differ very materially from those of unhardened steel. The material that the projectile now meets is less tenacious than homogenous unhardened steel, so that a cylindrical section of the plate in front of the projectile is forced out like a stopper. After penetration therefore the back of the plate presents the appearance of a plate hardened throughout. The stopper of metal forced out of the plate is usually broken up into several pieces because the head

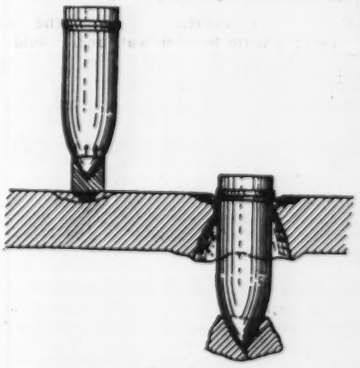


Fig. 8.

of the projectile having passed through without injury, in normal penetration, this piece remains about the thickness of the caliber of the projectile. Hitherto no trace

*According to the theory of Prof. Fr. Kicks there forms under the working surface of the tool in compression a thick conical-shaped body in the material worked, which facilitates deformation and splitting. The existence of this material-cone is readily detected by means of plates specially prepared. In pressure tests with very brittle material (sandstone) the material-cone breaks directly out of the body tested.

of the cap has been found. Probably it is driven radially on penetration, and broken up, so that its pieces mingle with the fragments of the plate.

The superiority of the action of capped as compared with uncapped projectiles rests therefore, as stated, on the fact that the head of the projectile remains intact. With the ordinary projectile the velocity upon impact falls off so suddenly towards zero, that the pressure increases until it reaches a point where the cohesion of the metal of the projectile is overcome; with capped projectiles, however, on account of the distribution of the pressure over a larger area, the pressure per unit of area does not reach this limit, and it still remains below this limit in further penetration, because the hardened exterior layer is weakened by the formation of the material cone. The pressure curve for capped projectiles against hard plates will therefore resemble that for pointed projectiles against soft plates. At first, while the ogival head is entering the plate, the curve will slowly rise until the head has completely entered. When the stopper of metal breaks out of the plate, the curve will fall steeply, so that at this point it will show an angle. This curve represents the total pressure, for the pressure per unit of area decreases from the start because with the increase of the total pressure, the surface receiving it also increases.

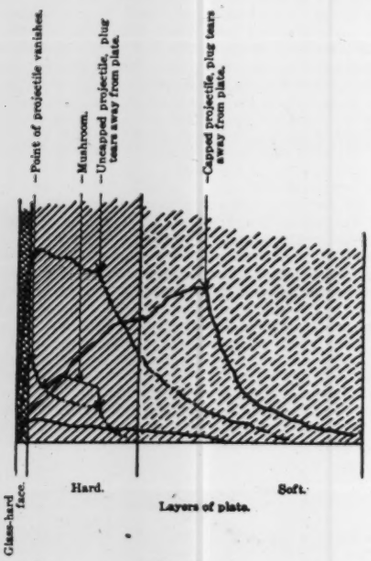


Fig. 9.

On the other hand the pressure curve for uncapped projectiles resembles that for a flat-headed projectile. The total pressure rises rapidly, and maintains itself at about a constant height so long as the shearing strength of the plate at the place of impact is not overcome; once the plate is punched it sinks rapidly. The pressure per unit of area on the head grows rapidly from the instant of impact until the head as such disappears. The area included between each curve, the axis of abscissas, and the extreme ordinates, must be equal in each case, since this area represents the work done.

It will be apparent from this discussion that the problem of the capped projectile, remarkable as the results appear at first sight, is yet capable of an explanation on a simple mechanical basis. The transfer of the pressure from the surface of impact, the front of the cap, to the working cross-section of the ogival head takes place in a wave motion at an enormously high velocity, practically instantaneously, and the pressure may be regarded as completely and uniformly taken up, if the cap is firmly seated upon the projectile. A good solid attachment of the cap to the body of the projectile is therefore the weightiest factor in the construction of the capped projectile. In order that the transfer of pressure may properly be accomplished, the cap must be seated in the closest contact with the projectile's head throughout its entire interior surface. If this condition is fulfilled, it insures that the cap will not part from the projectile either in the bore or in the air; the first might lead to accidents, the second to wild shooting. Such a firm and absolutely reliable attachment is only to be secured by means of metallic soldering. This method would also remove the defects due to any small room for play that might remain between the cap and the projectile after grinding. A solder suitable for this purpose must possess two qualities; first it must possess sufficient firmness, and secondly a low point of melting so that the tempering of the point will not be affected during the process of soldering. This requires that it should lie considerably below 200° C. Now these two qualities are opposite, since ready melting usually goes with small firmness. Thus there are difficulties in the way of obtaining a suitable alloy, so that the method of soldering is not in general use.

The method of soldering has the advantage that projectiles on hand can be easily fitted with a cap, and in manufacturing new shell no regard need be paid as to whether they will or not be furnished with a cap. A great advantage of soldering in comparison with other means ordinarily employed to attach the cap, lies in the fact that by this process the head of the projectile is not weakened, as it is when grooves or channels are turned in the head. Ridges in the vicinity of the head have the disadvantage that they are liable to cause a cracking upon tempering. When grooves are turned into the head in the finished projectile, the exterior surface is injured, and it may happen that the hard outer layer already under tension may be broken by the strain from within. Not only may the head be cracked in this way, but the whole projectile may disrupt before it is ready to be used.

Another method of attaching the cap is to screw it on the head. Of course this method applies only to the new projectile before hardening.

As regards the material out of which the cap is made, it appears on the whole, that there is more freedom of choice in this than would seem likely at first. The naval-technical committee employed in its experiments a number of different materials, differing very widely in their physical properties and yet no variation was observed in the results. Probably each firm and each State that conducts experiments with capped projectiles uses a different material from any other, with results more or less satisfactory. The chief requirement is a proper amount of elasticity of compression (the material must not be too soft), and a relatively large tenacity, so that the cap will not fly to pieces on impact with the plate.

Nor does it appear that the form of the cap has much effect on the results, since nearly every manufacturer chooses a different one. Some of the more common ones are represented in Fig. 10, but there are a great many forms besides these. It is essential that the front of the cap should present a broad surface and that it should rest against a large cross-section of the head. The first creates a larger material cone in the plate, the latter diminishes the unit pressure on the head. In any case the best form is the one that produces an adequate effect with a minimum volume and weight. On ballistic grounds it is indifferent what form of head is adopted, for with great velocities this modifies the trajectory very little, which is not the case with low velocities. The greater the velocity the less important is the shape of the head. At the same time it is to be noted that the displacement of the center of gravity towards the point influences favorably the trajectory, increasing both accuracy and range. Many tests by the Krupp firm confirm this fact respecting capped projectiles.

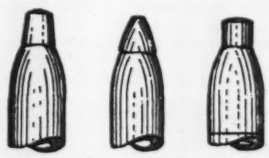


Fig. 10.

Besides the advantage that the capped projectile possesses over ordinary uncapped shell, in that its penetrative power is increased about 20%, there remains to be mentioned the following advantage of the new type, namely, that the shell goes through the plate whole or at the limit of its energy breaks into a few large fragments. This tends to increase the bursting effect very much. The bursting charge of the ordinary armor-piercing shell (and the same applies still more to the weakly constructed fuzed shell) can never be fully utilized because the shell is shattered on the hard exterior surface, so that the explosion occurs in front of the plate and thus outside of the protected area. At best only a few fragments arrive back of the plate and these make a dangerous conical space only in the prolongation of the trajectory. The whole territory back of the place of impact is not rendered unsafe as it should be upon the penetration and explosion of a shell. A satisfactory shell explosion can only occur when the shell arrives intact behind the plate. The use of high explosive preparations insures a mine effect with capped projectiles, even when the inner cavity is small, and a result is produced much greater than that of uncapped fuzed shell that have a much stronger bursting charge.

Unfortunately, the value of the cap is not the same for all velocities. A pronounced superiority of the capped projectile compared with ordinary shell is only to be secured with high striking velocities. With low velocities even when the capped projectile has sufficient energy to penetrate the thinner plate, the effect of both types is about the same. Hence, at long ranges the capped projectile is no more effective than ordinary shell. The limiting velocity is about 500 m. sec. (1650 ft. sec.), and as this velocity with 12 cm. L/40 (4.7-in., forty caliber) guns is attained at ranges of 2,000 and to 2,400 m. (2,200 to 2,625 yds.), and with 15 cm. L/40 (6-in. forty caliber) guns at about 2,800 m. (3,100 yds), and with modern 24 cm. guns (9.5-in.) guns at about 7,000 m. (7,650 yds.) it will be seen that the utility of the capped projectile is at best limited to close fighting ranges. At these ranges the effect of the shell is so increased that the cap is of great advantage; beyond the limits indicated above the cap is of no advantage.

SMOKE ABATEMENT AT INDIANAPOLIS.

In our issue of Aug. 31 we published an abstract of a paper on smoke abatement read by Mr. R. P. King, Smoke Inspector of Indianapolis, before the meeting of the League of American Municipalities at Toledo, the previous week. In response to inquiries, Mr. King has sent us some printed matter and other information regarding his work at Indianapolis. Mr. King is a member of Brossman & King, Consulting Engineers, Indianapolis, and has served as smoke inspector since November, 1904. Since that time, we are informed, he has "cleaned up an average of 12 boilers per month, some of which were the worst smokers in the city." A large part of his work is, of course, educational. Through the Indianapolis Department of Building Inspection, under which his work technically falls (Geo. W. Stanley, Building Inspector), "A Bulletin to Steam Users, Architects and Contractors" has been issued. This contains much information on smoke prevention, adapted to the needs of users of Indiana soft coals. The smoke prevention ordinance is printed in the bulletin. It is unnecessary to make extracts from the bulletin or the ordinance, since a number of points taken from each were given in the paper already mentioned as having been abstracted in our issue of Aug. 31. Those wishing more details can doubtless obtain the bulletin by sending a postage stamp and their address to Mr. King.

Under the ordinance, persons wishing to install or alter boilers or furnaces must fill in an application blank stating the style and make of the boiler in question, the number and size of tubes, height and diameter of chimney, to what steam is supplied, the method adopted to prevent smoke, and the name of the owner and contractor. This blank is 5 × 8¼ ins. in size.

In reporting the results of inspections a blank about 8¼ × 11 ins. is used, which we reproduce in condensed form, as follows:

Inspection No.....

SMOKE INSPECTOR'S REPORT.

Furnace owned by.....
Located at.....
Date of inspection.....
Length of inspection.....from.....to.....
No. of furnaces .....
Type of furnaces.....
Method of firing.....
No. of attendants.....
Were attendants competent?.....
If boilers, sq. ft. heating surface.....
If boilers, sq. ft. grate area.....
No. and height chimneys (approx.).....
Inches of chimney draft.....
Breeching draft.....
Kind of fuel .....
Amount burned per hour.....
Water evaporated per hour.....
Composition of flue gases.....
Was chimney smoking?.....
How? .....
Average with smoke cards, 30-minute intervals.....
Were photographs taken?.....File No.....
Description of plant.....

Remarks .....

Signed.....

For taking records of chimney observations a blue print chart (blue lines on a white ground) 16½ × 3 ins. over all is used. This is ruled vertically to give half-minute records of "Black," "Dense," "Gray" and "Clear" appearances of the chimney top under observation.

SEVENTY TONS OF DYNAMITE were exploded on Sept. 28 in the hold of the steamer "Chatham," which had been sunk in the Suez Canal about 12 miles from Port Said on Sept. 6. The steamer was sunk to extinguish a fire which had broken out, and which it was feared would reach the dynamite cargo. Cans of blasting gelatin were placed in the cargo of the sunken steamer and fired. The explosion threw a column of water 2,000 ft. into the air, broke down some 600 ft. of the east bank of the canal, and destroyed the telegraph and telephone lines, besides injuring adjacent property. The wreck of the steamer still remains to be removed from the channel.

NEW CONCRETE TIES AND STEEL TIES.

The ease with which experimental designs for concrete ties can be molded has led to a number of tests in service being made with them. We illustrate herewith two forms of reinforced concrete ties which are now being tested. Steel ties also continue to be experimented with, and a new design of steel tie which is now in service under exceptionally heavy traffic is also described.

CAMPBELL TIE.—This design is the invention of Mr. R. B. Campbell, General Manager of the Elgin, Joliet & Eastern Ry., who informs us that 140 ties have been in use from eight to twelve months, while 1,000 more are being made and will be put in use under heavy traffic on the Chicago, Lake Shore & Eastern Ry. (of which also Mr. Campbell is General Manager).

The tie is approximately rectangular, with beveled corners, but at the rail seat the top is level for the full width, and has embedded in it a flat tie-plate consisting of a grooved and shouldered tie-plate laid upside down. This plate is 8½ ins. square. The ties are reinforced by two 2¼-in. wrought iron pipes (scrap boiler tubes) and by an oval wrapping of chicken wire, as shown in the sections. At the rail seats also, each pipe has a ¼-in. slot, 6 ins. long, cut in the side, and in this is inserted a sheet of heavy wire netting 5 × 8½ ins. Each rail rests upon a flat tie-plate and is secured by a ¾-in. U-bolt having a spread of 8 37-64 ins., placed diagonally. A 15-16-in. cast washer, 4 × 2 5-16-in. on top, is slipped over each end of the bolt and held down upon the rail base by a nut. The ties are 6 ins. deep and 7 ins. wide, except that at the rail seat the width is increased to 10 ins. The length is 8 ft. 6 ins. The concrete is composed of 1 part Portland cement, 2 parts sand and 3 parts of crushed stone, screened gravel or crushed slag. The average weight is 356 lbs., including 35 lbs. of steel reinforcement, and the ties can be made and sold at a price of $1.50 to $1.75 each. The tie is in an experimental stage, and 19 have failed owing to faulty mixture, the sand containing too much loam; but it is believed that the tie will prove a success.

Tests of several of these ties were made in a Riehle testing machine. All the ties were 7 × 7 ins. and 8 ft. 6 ins. long, and fitted with tie-plates. In a crushing test, with the load applied at the rail seat, one tie developed the first crack at 80,000 lbs., and crushed at 100,000 lbs. Twelve ties were placed inverted with their tie-plates resting on blocks 5 ft. c. to c., and had the load applied at the middle. Three others were placed in the same way, but carried blocks at the ends on which rested a beam to which the load was applied. The ties were made of different kinds of concrete, and reinforced with one and two tubes. The results are given in Table I.

TABLE I.—TESTS OF REINFORCED CONCRETE TIES.—(Load applied at Center.)

Tubes No.	Tubes Diam.	Weight of Tie.	Age of Tie.	Composition of Concrete (1 cement).		Load Cracked at	Load Broke at	Deflection At Crack	Deflection At Break
No.		lbs.	days			lbs.	lbs.	in.	in.
1	3	....	119	2	sand, 3 bank gravel	.....	4,000	....	.109
1	3	....	196	2	sand, 3 wash. bank gravel	4,000	5,000	.184	.456
2	2¼	....	117	4	limestone screenings	.....	5,000	....	.435
1	3	....	195	2	sand, 3 wash. bank gravel	4,000	5,400	.209	.438
2	2¼	385	120	3	limestone screenings	4,000	5,400	.195	.435
2	2¼	....	116	2	sand, 3 wash. bank gravel	4,400	5,400	.198	.440
2	2¼	293	152	2	sand, 3 bank gravel	2,000	5,600	.040	.320
2	2¼	....	116	2	sand, 3 bank gravel	4,800	5,800	.152	.300
2	2¼	401	116	3	crushed stone	5 200	5,800	.272	.425
2	2¼	364	147	2	sand, 3 slag	4,800	7,600	.183	.421
1	3	....	94	3	crushed stone, 2 lime, screenings	.....	7,800	....	.511
1	3	311	195	2	sand, 3 wash. lake gravel	7,200	9,800	.245	.415
					(Load applied at ends.)				
2	2¼	355	200	7	crushed stone	10,000	11,400	.265	.465
2	2¼	....	196	2	sand, 3 wash. lake gravel	8,200	13,000	.084	.104
2	2¼	383	126	7	limestone screenings	.....	14,200	....	.572

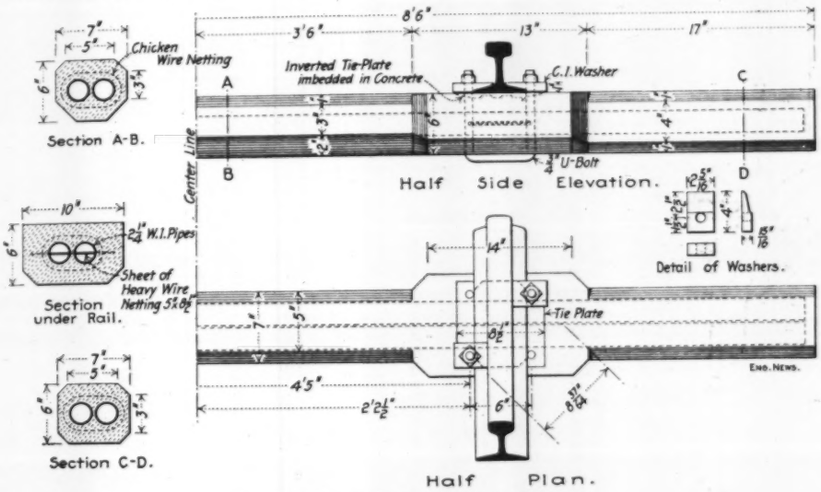


FIG. 1. THE CAMPBELL CONCRETE TIE.
R. B. Campbell, General Manager, Elgin, Joliet & Eastern Ry., Inventor.

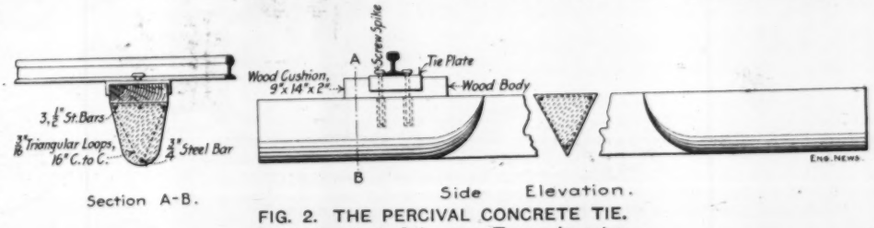


FIG. 2. THE PERCIVAL CONCRETE TIE.
H. J. Percival, Galveston, Texas, Inventor.

PERCIVAL TIE.—This tie, shown in Fig. 2, is the invention of Mr. H. E. Percival, 1316 Ave. I, Galveston, Tex. It is 8 ft. long, triangular in section for 4 ft. at the middle, while the end portions have the sides more nearly vertical and the bottom rounded. It is 9¼ ins. wide on top and 10 ins. deep. The reinforcement consists of three ½-in. Johnson corrugated steel bars in the top and a single ¾-in. bar in the bottom; over these are triangular stirrups or loops of 3-16-in. wire, placed 16 ins. apart. Each rail rests on a 2-in. cushion block of treated wood, 9 × 14 ins. The weight of the tie is about 400 lbs. The fastenings, Fig. 3, consist of ¾-in. screw spikes entering sleeves or sockets of babbit metal embedded in the concrete. Other designs for fastenings by clamps, etc., have been made; in one of these, the ends of the tie are hollow, and receive the nuts for bolts which are screwed in from above, the nut being held by a wrench. In June last, the Galveston, Houston & Henderson Ry. laid 25 of these ties at Galveston, Tex.; they are spaced 20 ins. c. to c. in shell and sand ballast and carry 66-lb. rails. Mr. J. J. Powers, Roadmaster, reports that the fastenings are satisfactory.

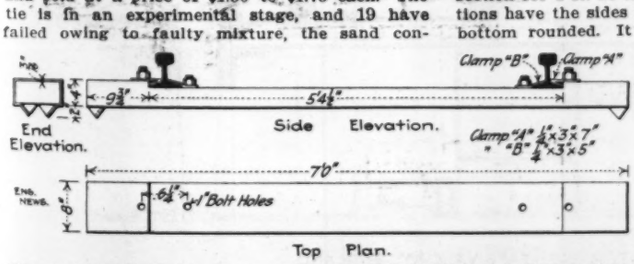


FIG. 4. THE McCUNE STEEL TIE; MONONGAHELA CONNECTING RY.

McCUNE TIE.—A steel tie of channel section has been designed by Mr. Frank McCune, General Superintendent of the Monongahela Connecting Ry., at Pittsburg, Pa., and is now being tried on that road, the first lot having been made by Jones & Laughlin. The tie, shown in Fig. 4, is of 3-16-in. sheet steel, pressed to form a rectangular channel 4 ins. wide, 3 ins. deep at the middle and 4 ins. at the ends, the raised ends forming a shoulder to support the rails. At the ends the bottom corners are turned down to project 2 ins. below the face of the tie, these projections serving as anchors to prevent lateral movement in the ballast. Each rail is held by two clamps and two 1-in. bolts. The weight is only 97 lbs. which is claimed as an advantage in handling and renewing ties, but experience is rather against ties of very thin metal and light weight, both in regard to durability and stability. However, the experimental ties will be subjected to very severe service, as they have been laid in the westbound main track where the heaviest traffic is carried; six-wheel switch engines weighing 120 tons run continually over this piece of track, and there are also a number of cars built to carry 200,000 lbs. of ore and pig iron. There are at present 30 of these ties under two rail lengths of 33-ft. rails of the 85-lb. Am. Soc. C. E. section, and others are to be manufactured. The cost is said to be $2 per tie.

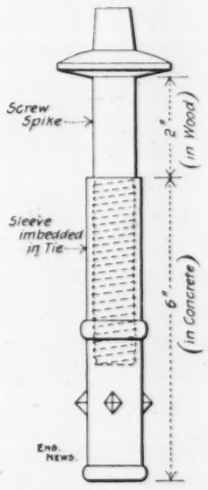


Fig. 3. Rail Fastening for Percival Concrete Tie.

A DIAMOND DRILL HOLE, 5,560 ft. deep, has been put down at Doornkloof, South Africa. A 1⅝-in. core was obtained. The time to drill this hole was 14 months, or an average of nearly 400 ft. per month. Three 8-hour shifts were worked daily. The rods were pulled out in lengths of 50 ft. At a depth of 5,000 ft. it required 3½ to 4 hours to raise the rods, and almost as much more time to lower them.—Another hole, 5,582 ft. deep, has recently been completed near Johannesburg, the time required to drill it being 9 months, or an average of 620 ft. per month.

STEAM MOTOR CARS ON THE TAFF VALE RY., ENGLAND.

The Taff Vale Ry. is one of the numerous English railways now operating steam motor cars, having now six of these cars in service on different parts of its lines. The cars are 58 ft. 9 ins. long over all, 45 ft. long in the body, 8 ft. wide, and weigh 33 tons in working order. The body has two passenger compartments seating 52 passengers and has also a baggage compartment. At the rear is a platform with entrance to the rear compartment, while a transverse gangway has entrances to the baggage compartment and the first passenger compartment. The front end of the car frame is supported by the engine, and there is a four wheel truck under the rear end, the total wheelbase being 49 ft. 3½ ins. The rear truck has 34-in. wheels and 8-ft. wheelbase. The engine and boiler equipment for cars of this class is of particular interest, and we illustrate herewith the equipment of the steam cars above noted, for the drawings of which we are indebted to Mr. T. Hurry Riches, Locomotive Superintendent of the Taff Vale Ry., by whom they were designed. The engines were built by the Avonside Engine Works and the cars by the Bristol Wagon & Carriage Works Co.

The engine has deep plate frames, and a transverse box frame or bolster for the center is attachment to the end of the steel underframe of the car. It is mounted on four wheels, but these are not coupled, nor are their springs equalized. The outside cylinders are placed just forward of the rear wheels and drive the front wheels only; the Stephenson link-motion valve-gear is used, with a rocker connection to the valve stem. A

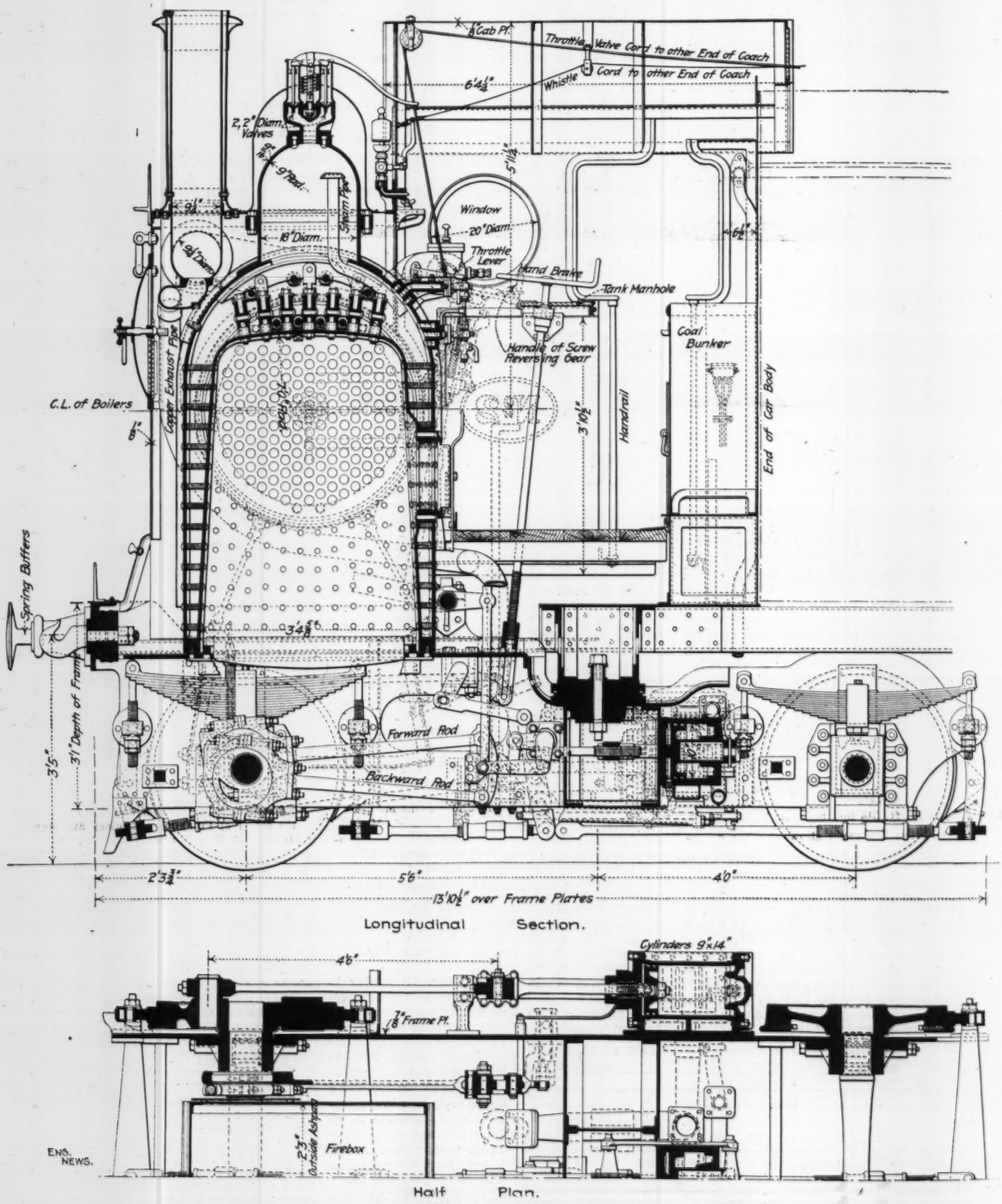


FIG. 1. ENGINE AND BOILER OF STEAM MOTOR CAR; TAFF VALE RY., ENGLAND.
T. Hurry Riches, Locomotive Superintendent.

screw reversing gear is used. The most notable feature is the boiler. It has a rectangular copper firebox, with a barrel and set of horizontal tubes on each sides, at right angles to the center line of the engine. The smoke and gases enter two smokeboxes, from which 9¼-in. flues lead to the base of the smokestack, which is on the center line of the engine and over the front end of the boiler. The dome is placed directly over the firebox, and has the safety valves fitted to the top, the whole being enclosed in a dome casing of polished brass. The cab extends to but does not enclose the boiler, and has a tank on each side, with a coal bunker at the rear. The engine is fitted with hand and vacuum brakes, and cords

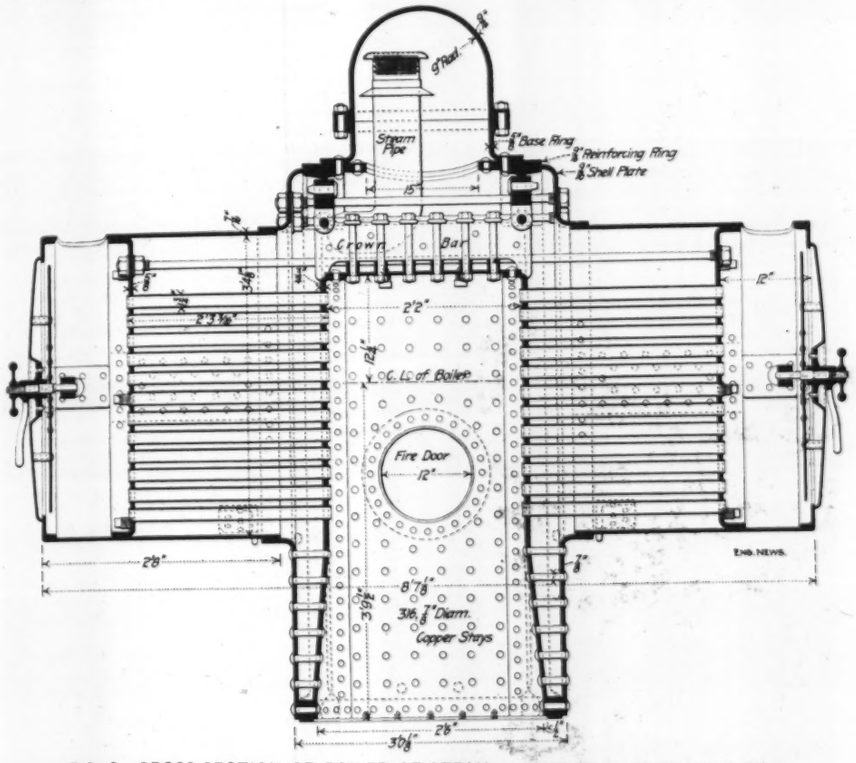


FIG. 2. CROSS-SECTION OF BOILER OF STEAM MOTOR CAR; TAFF VALE RY.

are led from the cab to the rear end of the car to enable the conductor to sound the whistle and close the throttle if necessary.

The driving axle is 6 ins. diameter in the bearings, and its springs have 17 plates 3½ ins. wide and 7-16-in. thick, except that the top plate is ½-in. thick. The trailing axle is 5 ins. diameter in the bearings, and its springs have plates 3½ ins. wide; 14 are ⅜-in. thick and one is ½-in. thick. The wheels are 4 ft. 5½ ins. back to back of tires.

The construction is clearly shown by the drawings, Figs. 1 and 2, and the general dimensions are given below:

DIMENSIONS OF ENGINE OF STEAM MOTOR CAR: TAFF VALE RY., ENGLAND.

Driving wheels (2), diameter	2 ft. 10 ins.
Trailing wheels (2), diameter	2 ft. 10 ins.
Wheel centers	Cast steel
Wheelbase	9 ft. 6 ins.
Weight of engine and car in working order	33 tons
Cylinders	9 x 14 ins.
Connecting rod, length	4 ft. 6 ins.
Valve gear	Stephenson link
Boiler, diameter of each barrel	3 ft. 4⅛ ins.
Dome, diameter	1 ft. 6 ins.
Boiler	Double barrel
Diameter of each barrel	3 ft. 4⅛ ins.
Diameter of dome	1 ft. 6 ins.
Barrel plates	7/16-in.
Firebox shell plates	9/16-in.
Smokebox tube plates	⅝-in.
Rail to center line	6 ft. 11 ins.
Smokeboxes, length	1 ft. 0 in.
Working pressure	160 lbs.
Firebox: Copper	Rectangular
Length, inside	3 ft. 4⅛ ins.
Width, inside	2 ft. 6 ins.
Depth, inside	4 ft. 9¼ ins.
Crown and side plates	½-in.
Tube plates	⅝-in.
Staybolts, copper; diameter	⅞-in.
Crown stays	Crown bars
Water spaces, width	2 to 7 ins.
Tubes: Brass; No. in each barrel	132
Diameter, outside	1¾ ins.
Length over tube plates	2 ft. 3 9/16 ins.
Heating Surface: Tubes	299.5 sq. ft.
Firebox	39.0 sq. ft.
Total	338.5 sq. ft.
Grate area	8.0 sq. ft.
Smokestack, diameter	9¼ ins.
Capacity of water tanks (total)	636 U. S. gallons
Capacity of coal bunker	1,120 lbs.
Tractive force, with effective pressure equal to 80% of boiler pressure	4,263 lbs.

TUNNEL CONSTRUCTION AND THE SUBSIDENCE OF STREETS IN CHICAGO.

The settlement of streets in Chicago, and the effect of this movement of the ground in relation to building foundations, is receiving further attention, and is evidently a serious matter. In our issue of Aug. 24 we published a very complete abstract of the report made by a special commission of engineers in regard to the telephone and transportation tunnel system in Chicago, and the relation of the tunnel work to the street settlements which have occurred recently and which have given rise to some apprehension as to the safety of several large buildings. The Tunnel Commission was composed of Mr. John M. Ewen, M. Am. Soc. C. E.; Mr. E. C. Shankland, M. Am. Soc. C. E., and Mr. L. E. Ritter, and was appointed by the Commissioner of Public Works, Mr. J. M. Patterson.

The first report presented the conclusions that no settlement had occurred where the main tunnels had been built under air pressure, but that there was convincing evidence that such settlement had occurred as a result of the building of connections, by-passes and new drifts without air pressure. As a result of this, the Commissioner of Public Works requested the Tunnel Commission to state more fully the evidence upon which the second conclusion was based, owing to its important bearing upon the effect of the tunnel construction on the city streets and the foundations of buildings. A second report, therefore, has recently been made, and as it deals with a matter of great interest and importance to engineers we give it herewith, practically in full:

In our report made on Aug. 14 we stated that we could find no damage due to settlement of streets or buildings where the work was confined to the main line tunnels. It was not until the greater portion of the tunnels was finished in the downtown district and the work of making connections to buildings was attempted that settlements were noticed. The main tunnel, as constructed in each case, below the middle of the street, fell outside the lines of pressure from the buildings on either side. It was only necessary to consider the load from the clay above, but in the case of the by-passes and connections to buildings, it is apparent that the excavation would be in clay that was under pressure from the weight of these buildings as well as under pressure from the weight of the clay above. The larger portion of this work has been executed under air pressure of about 8 or 10 lbs., which pressure has aided materially in preventing settlement of the streets. A small portion of this work has been executed without air pressure without any apparent settlement of the streets, but as the risk in doing the work without air pressure was greater, apparatus and men were constantly kept in attendance to stop any caving that might occur.

When it became necessary to build by-passes and connections to buildings, soil under greater compression had to be cut into, and the conditions encountered grew more serious in exact proportion as the work came nearer to this soil under greater compression, and the whole engineering proposition became more difficult. From the commencement of our investigation it has been very apparent to us that this condition of affairs has not been fully realized by those in charge of the work, for without materially changing the method of operation, connections have been attempted at several places with the result that settlements and damage to streets and building have taken place. We present the following instances:

1. The settlement at the intersection of State St. and Jackson Boulevard. 2. The settlement of the northwest corner of the Pullman Building, at the corner of Adams St. and Michigan Ave. 3. The settlement of Adams St. in front of the Republic Building. 4. The settlement of the southwest corner of Marshall Field's wholesale building, at the corner of Franklin and Quincy Sts. At all of these places the fact that settlements have taken place has been apparent to the eye, and needs no further verification. The facts that led us to the conclusion that these settlements were due to the tunnel operations are as follows:

The sinking at the intersection of State St. and Jackson Boulevard was caused when the turnout curves at the intersection of the tunnels were constructed. In making the excavations for these curves, the face of the clay that was uncovered was too great to allow of its self-support, and the movement of this clay before a new support could be supplied caused the settlement of the street surface of about 9 ins. The company admitted that this was due to carelessness on the part of the employees in attempting to do too much of the work at one time.

The settlement of the sidewalk and corner pier of the Pullman Building we believe was due to the fact that too great a surface of the clay in the tunnel was exposed at one time, so that the movement in the clay was transmitted to the foundations of the building, and settlement occurred. This connection was continued under the alley for a distance of about 50 ft. from the center of Adams St., and is now bulkheaded and no further work is being done.

A decided settlement of the street (between 1 ft. and 2 ft.), at the north side of the Republic Building, corner of State and Adams Sts., took place during the construction of this building. The tunnel company took the contract to remove the clay from the excavation of the building, and they started to build a connection to be used for this purpose temporarily, and afterwards to be made into a permanent connection to the building. Before this connection was provided the settlement occurred, and the connection was bulkheaded and abandoned, and the tunnel company removed the clay by wagons.

The settlement of the Marshall Field wholesale store at the corner of Franklin and Quincy Sts. occurred suddenly on May 25, and cracked the stone work from the street level to the top of the building, some of the cracks being from 4 to 6 ins. in width. As the statement has been made several times that this settlement was due to the building of the caisson foundations of the Chicago & Northwestern Ry.'s new office building, which stands directly opposite on Quincy St., we deem it proper to give a brief history of the case.

The caisson foundations of the Northwestern Building were completed on June 19, 1904, and all of the steel work of the building was completed on November 3 of that year. Before the foundation work was started, bench marks were established on all the buildings surrounding the Northwestern Building, including points on the Marshall Field Building. Levels were taken at frequent intervals during the construction of the former building, and at the end of December, 1904, about two months after completion of its erection, and when all settlements to surrounding buildings had ceased, it was shown that no damage was done to the Field Building excepting a slight crack in one window sill. This crack was noticed in the summer, and its condition was unchanged when levels were taken in December, 1904.

On May 25, 1905, when the sudden settlement to the Field Building occurred, another set of levels was taken on that building, and continued throughout the summer, the last being taken September 1, 1905, showing a settlement during this time of 3⅛ ins. Mr. W. R. North-

way, Assistant City Engineer, in his report to this Commission dated July 27, 1905, concerning this matter, stated that this tunnel connection was started on May 11, 1905, and "the last mining was done the night of May 24, and both ends connected and bulkheaded May 25, 1905." The curb wall of the Chicago & Northwestern Ry. office building in Quincy St. cracked horizontally the same date, May 25. This crack begins at Franklin St., and extends east 35 or 40 ft. All the above is conclusive proof to us that the damage to the Field Building was due to the tunnel operation at the time, and not to the operation of the foundations of the Northwestern Building, which took place one year previous.

Diagrams accompanying the report show the settlement at five bench marks on the Field Building, and these we tabulate below. The settlements from March to December, 1904, occurred during the construction of the foundations of the Northwestern Building. The additional settlements from May, 1905 (when the tunnel company abandoned work on its connection), to September, 1905, were due to the tunnel construction, and three of these latter show sudden initial settlements of 1½ to 2½ ins.

	Settlements. First, March to Dec., 1904.	Second, May to Sept., 1905.
	ins.	ins.
1	1¼	3⅜
2	2¼	3⅛
3	17/32	¼
4	2 13/16	2¼
5	1 21/32	11/16

The tunnel company has permits to connect with many buildings in the downtown district, but so far it has only completed four connections in addition to the connections to its own buildings. The connection to the Heyworth Building (Madison St. and Wabash Ave.) is a curve of the tunnel leading into the deep basement of that building on the same level as the tunnel. The Heyworth Building stands on caisson foundations. Another connection has been completed into the basement of the Majestic Theater building on Monroe St., consisting of a by-pass, tangent to the curb wall on the tunnel level, and the vertical shaft reaching from this by-pass to the basement of the building. This building also stands on caisson foundations. Another connection is being made to Marshall Field's retail store on State St. similar in character to that in the Heyworth Building. This building also stands on caisson foundations. The fourth is to Mandel Brothers' building on Wabash Ave., which is also on caisson foundations. A number of temporary chutes have been built connecting the tunnel with buildings now in course of erection. These chutes lead at an angle from the basements of the buildings to the roof of the tunnel, and are used for conveying the clay excavated to cars in the tunnel for removal to the lake front. No other connections, so far as we can ascertain, have been made.

There is no reason why they should not be put in, providing a scheme be developed to meet the conditions that are peculiar to each case. It is not feasible to make a plan that could be safely followed for all connections. It is manifest that the least complicated cases will occur when the building to be connected with stands upon caisson foundations. Even then damage may be expected to adjacent buildings that stand upon spread foundations, and consequently streets in front of these buildings might be affected. Buildings resting upon pile foundations may be in most cases classed with buildings resting upon caisson foundations.

The cases where old buildings have been erected on spread foundations, which do not extend to the blue clay, would probably present a great many difficulties, and a plan would have to be carefully studied out to meet each case. The most difficult and dangerous cases to handle will be those of the high, heavy buildings resting upon spread foundations. Connections to them will require the utmost care, both in planning and in execution.

We have believed from the commencement of the investigation that the problem of making these connections to the tunnels is one that will tax all the ingenuity and skill of the engineer, and is of greater importance from an engineering point of view than the construction of the tunnels themselves. It should be treated with the greatest care by both the tunnel company and the city before the work is prosecuted. A comprehensive scheme should first be agreed upon, and the proper steps taken to see that it is rigidly carried out. Even then there will probably be some settlement; but it can be reduced to a minimum.

In our opinion it is not practicable to work under air pressure in making the connections, neither do we believe the air pressure would be sufficient to sustain the pressure of the foundations upon the soil. The soil must be held by mechanical means in some such way as the caissons or wells are sunk to form the foundations of heavy buildings. It is a building proposition, and the methods common in building practice will probably meet all the difficulties that may be encountered. The connection should be circular in section rather than elliptical, and the lagging should be put in with the greatest skill possible.

These cases to which we have called attention are the ones that form the basis of the conclusions in our former report. We have made no further investigations of this matter since this former report, but understand that there have been other cases of settlements. The cases we have quoted, so far as we have been able to ascertain, are the only ones where real attempts have been made to connect to buildings resting upon floating foundations, and since in each case settlements have taken place, we considered these facts sufficient for the conclusions in our former report.

THE "SEA MILLS" OF CEPHALONIA.

By Wm. P. Mason.*

Cephalonia, the largest of the Ionian Islands, lies off the west coast of Greece and is some thirty miles long by twenty miles broad. Near its principal town of Argostoli are mills equipped with undershot wheels which are driven by sea-water flowing landward from the coast.

In the words of Baedeker, "the mills are driven by a current of sea-water which flows into the land for about fifty yards finally disappearing amid clefts and fissures in the limestone rock."

The Sea-Mill of Cepha'onia.

The illustration shown herewith is of the "Old Mill" erected in 1835, and shows the water flowing in the tail-race towards the point of its mysterious disappearance, which is some ten ft. below the level of the sea. The question is, where does the water go?

Mr. S. F. Houston, who supplied the writer with the above measurements, adds that during the British occupancy of the island, pitch, petroleum and other easily noticeable substances were poured into these "clefts and fissues" and that a strict watch of the surrounding sea failed to detect their reappearance.

Is it not possible that the water which sinks into the rocks of Cephalonia comes to the surface again in the form of steam at Stromboli, Vesuvius or other volcanic vents?

Crosby suggests another explanation, namely, that an extinct volcanic vent at Cephalonia receives the water and passes it to another similar arm of a mighty U. The water after reaching the lowest level becomes heated and then rises in the second arm of the U. Under such conditions constant flow in one direction would be established and the discharge might be made at some distant point of the sea bottom.

*Rensselaer Polytechnic Institute, Troy, N. Y.

THE INFLUENCE OF ARSENIC IN PICKLING SOLUTIONS.*

By Charles F. Burgess,† M. Am. Inst. E. E.

A sulphuric acid pickle which exerts a vigorous dissolving action upon an iron or steel surface may be rendered almost completely inert by the addition of a small amount of arsenic. Over a half century ago this fact was pointed out by E. Millon, who, however, did not attempt to explain the action. The phenomenon is of considerable significance to the chemist and the electrochemist, for it indicates that arsenic is a disadvantageous impurity where free and rapid action of sulphuric acid upon iron is desired; that its presence may be advantageous when the rapidity of the action of the acid is to be diminished. Millon claims that arsenic in acids other than sulphuric reduces the activity of such acids in corroding various metals. Assuming this to be true, may it not be expected that arsenic when present as an impurity in the metals themselves may render them less susceptible to corroding influences in general?

The writer has been unable to find that the attention has been given to the study of this subject to which its suggestiveness and usefulness entitles it. In what manner arsenic renders an iron surface passive is possibly a question for the electrochemist to answer, and any suggestions or information bearing upon this point will be welcomed by the author. Some preliminary experiments upon the effect of arsenic in sulphuric acid solutions have been done in the Applied Electrochemistry Laboratories of the University of Wisconsin, some of the results of which are here given.

A five normal solution of sulphuric acid was used in various tests, and to a portion of this solution was added a small quantity of arsenic in the form of As_2O_3. Although the exact quantity was not determined, it was present only as a small part of one per cent. To determine quantitatively the influence of the pure and the arsenic-containing solutions, strips of spring steel were subjected to their action, and the dissolving and the weakening of the steel measured. The steel ribbon used consisted of a high grade of untempered spring steel, carrying a thin film of black scale, and having a cross-section of 0.16 × 5-16-in. From this, pieces about 1 ft. in length were cut, and these were immersed for a depth of 6 ins. in the respective solutions.

Table I. gives results on the dissolving effect of the acids upon strips which had been freed of scale by rubbing with fine emery.

The facts to be noted from this table are that in one hour's time the amount of iron dissolved by the arsenic-free solution is about 34 times that dissolved by the impure solution; also that during the first twenty minutes the ratio between the action of the two solutions was 9.1 to 1, and during the last forty minutes the ratio increased to 94 to 1, showing that the protective action of the arsenic increases with the time. In the pure solution the rate of corrosion increases, as shown by the fact that over four times as much iron was dissolved during the last forty minutes as during the first twenty; while with the arsenic-containing solution the rate of solution materially decreased. It was also noted that when first immersing the steel in the impure solution hydrogen was given off, but this evolution quickly diminished and at the end of one hour the evolution of hydrogen had ceased, while in the pure acid the evolution of this gas was vigorous.

It is well known that acid solutions exert a harmful influence on steel, aside from that occasioned by the removal of some of the metal. This is supposed to be due to the liberation of hydrogen and the absorption of it by the metal, rendering the latter weak and brittle. So marked is this effect that certain classes of steel articles, such as steel piano wire, clock springs, measuring tape and the like cannot be pickled, and it is claimed by some that they cannot be nickel plated without damage.

To determine whether arsenic exerts an influence harmful or otherwise upon this weakening property of acids, a small testing machine was devised by means of which the brittleness of a strip of steel could be approximately determined. In this device the steel strip to be tested rests on two fixed edges spaced ½-in. apart. A movable edge midway between them is advanced slowly and steadily by means of a micrometer screw until the strip snaps in two, and the deflection thus measured is taken as an approximate indication of the flexibility.

Inasmuch as the steel strip showed variations in its flexibility on samples taken from various places in the coil, measurements were made on the pickled and un-

*A paper presented before the American Electrochemical Society, at Bethlehem, Pa., September, 1905.

†Professor of Electrical Engineering, University of Wisconsin, Madison, Wis.

TABLE I.—Dissolving effect on spring steel of acid with and without arsenic.

Time.	Pure acid solution. Wt. before.	Wt. after.	Loss.	Solution containing arsenic. Wt. before.	Wt. after.	Loss.
20 minutes	5.1628 g.	5.1156 g.	.0472 g.	5.0342 g.	5.0290 g.	.0052 g.
40 minutes	5.1156 g.	4.9096 g.	.2060 g.	5.0290 g.	5.0268 g.	.0022 g.
60 minutes.			.2532 g.			.0074 g.

pickled portions of each sample tested. The results of observations are given in Table II., the column marked "Per cent. weakening" being derived by dividing the deflection of the unpickled part by the decrease in deflection after pickling. It will be noted that arsenic exerts a marked influence in diminishing the rotting effect of the sulphuric acid solution.

TABLE II.

Solution.	Time.	—Deflection, Inches.— Pickled.	Unpickled.	Per cent. weakening.
Pure	5 minutes	.100	.152	
		.094	.156	
		.088		
	Average....	.094	.154	39.
With Arsenic	5 minutes	.156	.156	
		.152	.156	
		.154		
		.154		
		.158		
	Average....	.155	.156	0.64
Pure	10 minutes	.080	.170	
		.070	.160	
		.066	.158	
		.078		
	Average....	.074	.163	54.5
With Arsenic	10 minutes	.150	.170	
		.152	.166	
		.158	.170	
		.154		
	Average....	.154	.169	8.9
Pure	15 minutes	.062	.158	
		.054	.158	
		.066		
	Average....	.061	.158	61.4
With Arsenic	15 minutes	.142	.150	
		.150	.160	
		.152		
		.154		
	Average....	.149	.155	3.87
Pure	60 minutes	.060	.160	
		.056	.140	
		.050	.160	
	Average....	.056	.153	63.5
With Arsenic	60 minutes	.158	.178	
		.160	.174	
		.154	.172	
		.160		
		.160		
	Average....	.158	.175	9.7

A solution of hydrochloric acid having a corresponding strength was also tested, and it was found that while the arsenic in it exerts an influence similar to that exerted in sulphuric acid, the influence is not as pronounced.

It is generally recognized that the nickel-plating process, as usually operated, has a decided weakening effect on thin steel springs and the like, and the supposition is justified that it is the pickling part of the process that is largely responsible for the trouble. To determine whether a steel spring pickled in an arsenic-containing pickle and subsequently nickel-plated would be stronger than when pickled in pure acid before plating was the purpose of measurements given in Table III.

TABLE III.

	—Deflection.— Before pickling.	After plating.	Per cent. weakening
Pickled in pure acid and nickel plated.....	.172"	.140"	
	.172	.154	
		.140	
		.144	
		.148	
Average....	.172	.145	15.6
Pickled in acid containing arsenic and nickel plated.....	.160	.158	
	.168	.158	
	.172	.154	
		.146	
		.158	
		.154	
Average....	.167	.155	7.2

All the above experiments show that the effects of arsenic are sufficiently pronounced to warrant a further experimental study, especially in determining the quantitative effect of varying percentages of arsenic in various strengths of acid solutions. Such information will undoubtedly be of direct practical value to the electroplater and others who have to do with pickling solutions.

That arsenic exerts an influence to be reckoned with has been recognized for some time by users of sulphuric acid solutions. By some it is held to exert a deleterious influence; that its presence in a pickle gives rise to dark and irregular colorations on the surface of iron articles subjected to its influence, thus adding to the many difficulties inherent in the process of preparing surfaces for receiving electro-deposits. Another disadvantage attributed to arsenic is that it makes the useful action of the solution exceedingly slow. On the other hand, it is claimed by Meurice that the presence of arsenic may be decidedly advantageous to an acid pickle, since when present in suitable proportion it reduces the consumption of acid while increasing the effectiveness of its work.

RESULTS OF TESTS OF FIREPROOF WOOD AT THE INSURANCE ENGINEERING EXPERIMENT STATION.*

Attempts to render wood "fireproof," or rather fire-retardent, are not of recent origin, but it has not been until the necessity arose of providing fireproof "trim" for buildings built otherwise of non-inflammable material, that fireproof wood came to be made and put upon the market in quantity. Within five years its use has become more general, and, as is well known, its use in the United States Navy, and the legal requirement for its use in buildings of a certain class in New York City have called repeated attention to it.

Wood being porous, it is possible to cause solutions to soak into it and on drying to leave a part of the dissolved salt in the cellular structure of the wood. The application of heat and pressure sometimes following exposure in a chamber at reduced pressure, are the means often employed to cause the solutions to enter the wood. It is in the method of treating the wood, rather than the nature of the solutions used, that especial excellence is usually claimed for one or another brand of fireproof wood. So far as the writer can find out without exhaustive chemical analyses there is no great difference in the operation of the different salts with which the wood is treated. First, on heating the treated wood, it gives off vapors which surround the wood with an atmosphere which will not support combustion, being comparatively free from oxygen. In other words the fire is smothered by its own fumes. Later there is, in some brands, a tendency for the salts in the wood to calcine and coat over the inner portions of the wood with a refractory glaze. This again keeps out oxygen and reduces the vigor of the fire. In the first method of operation it is customary to rely on salts of ammonia, and phosphates, and for the latter on salts like alum and sulphate of alumina.

In examining fireproof wood it is at once apparent that it is in no sense proof against the action of fire, and it should be stated that the representatives of the makers of all the "fireproof" wood of which we could get trace agree that the wood is not fireproof, but desire to be understood as putting forward the material as being less likely to take fire, as burning with less flame, and as being much less likely, when once afire, to carry fire along its own length and breadth.

In July, 1902, and several times between that time and July, 1905, I have examined specimens of fireproof wood, and I desire in this report to present the results of the whole series, including the 1902 specimens which were reported upon in circular No. 1, of the Insurance Engineering Experiment Station.

Whenever time permitted the fireproof wood was examined so as to determine the following characteristics.

1. Ignition point. Length of exposure needed to ignite.
2. Amount and duration of flame.
3. Spread of flame.
4. Persistence and vigor of glowing embers.
5. Permanency of the treatment.
6. Permanency of treatment.
7. Effects on paint and varnish. Tendency to mold.

Material was sent for test by the American Wood Fireproofing Co., The Electric Fireproofing Co. and The Fireproofine Mfg. Co., all three doing business in New York City. A considerable number of specimens were sent to us by the George A. Fuller Co., after being taken from the buildings to which they had been supplied by some one of these three concerns, that we might have some knowledge of the material actually in service and note any progressive deterioration which should have occurred. A number of specimens came into my hands through clients, architects, or engineers.

All specimens were submitted to the following tests, except where the smallness of the specimen made it necessary to omit some one or two, and care was taken to see that any peculiar tendencies of these small pieces were demonstrated so far as possible. (1) Muffle test; (2) Hot plate test; (3) Cross-section test; (4) Cob house test; (5) Flue test; (6) Kindling test; (7) Exposure to dampness.

MUFFLE TEST.—Pieces of wood ¾ × ¾ × 6 ins. were placed in a horizontal electric muffle whose inside dimensions were 3 × 3 × 8 ins., the temperature being kept constant at 1,000° C., approximately 1,800° F. The size and duration of the resulting flame at the mouth of the muffle was noted and the condition of the wood on being withdrawn at the end of one, two, and five minutes. It became evident that information of value was to be gotten from this test only as follows, that all the specimens were completely consumed in less than five minutes, and that if the treated woods were withdrawn at the end of one or two minutes they continued to flame and glow only a few seconds, whereas the untreated wood would frequently flame for more than a minute, and that the treated woods all gave out about the same volume of smoke and flame, less in amount than that given out by similar pieces of untreated wood. Attempts to draw inferences as to the relative resistance of the several treated samples met with little success, because of the fickle nature of the flame and difference in the embers produced by adjoining portions of the same piece of wood.

*Report by Prof. Charles L. Norton, Engineer in Charge, 31 Milk St., Boston, Mass.

TABLE I.—Showing Results of Muffle Tests of Fireproof Wood.

Process.	Wood.	Specimen Received From	Height of flame, in.	Duration of flame after two-minute exposure to muffle, seconds.
Electric	Birch	Electric Co.	9	15
Electric	Oak	Electric Co.	10	10
American	Oak	American Co.	10	10
American	Spruce	American Co.	12	20
Untreated	Oak	.....	15	35
Untreated	Maple	.....	14	40

The volume of the flame given out by the untreated wood was estimated at three times that given out by the best treated wood. It is clear that all the specimens were destroyed, leaving little or no ash. Under this test no one of the specimens can be properly called flameless; however, the tendency of the untreated wood to flame on being heated is greater, and the tendency of the flame to persist is stronger. The igniting-point at which the wood will catch fire if slowly heated, is higher by nearly fifty degrees in the case of the fireproof woods, than in the case of untreated wood.

HOT PLATE TEST.—It has been claimed that the fireproof woods would not give off flame when placed upon a metal plate hot enough to thoroughly ignite them, but that they would char until consumed. After trial it seems that all that can be said of this test is that it shows only what is shown better by the muffle, namely, that the flashing-point of treated and untreated woods is about the same, and that the fireproofed specimens burn with less flame, and persist less in burning, than do the untreated specimens. If the temperature of the plate be low enough it is possible occasionally to cause the treated wood to char slowly away at a temperature which will cause the untreated wood to flame until consumed in large part.

CROSS-SEECTION TEST.—If a piece of wood about 1 in. square and 12 to 18 ins. long be held by its ends horizontally over the flame of a Bunsen burner, the rapidity with which the wood is destroyed may be judged by noting the time which it takes to burn the piece apart, or by noting the amount of wood remaining unaffected in the cross-section of the piece at the point of contact of the flame at any time. This test has been much used in New York, but I do not find it particularly helpful either in forming an opinion as to the absolute value of fireproof wood or as to the relative value of different specimens. I have had untreated specimens show the same or greater cross-section after exposure to the flame than do the similar treated specimens, and I am not sure but that the wood making a poor showing in this test is sometimes better than the average. Possibly the difference is due to the relatively large and variable volume of vapor from the specimens as compared with the volume of the gas flame itself.

COB HOUSE TEST.—This test was suggested by Mr. P. M. Stewart, formerly Building Superintendent for the Borough of Manhattan. It is, to my mind, the most conclusive method of demonstrating the essential difference between the treated and untreated woods. If some forty pieces of the wood under examination ¾ × ¾ × 6 ins. be piled in layers at right angles up on a grate or piece of wire netting, like a cob house, making a pile 6 ins. in each direction with numerous chinks and cracks, and it be placed over a flame from a Bunsen burner, it is possible to study the ease of ignition, the persistence of the flame, its spread from point to point, and the time required to destroy the whole pile, as well as to note the intensity of the fire.

In 1902 we found no difficulty in setting fire to and burning cob houses of this kind made of practically all the samples of wood sent us, and similar pieces were prepared for the 1905 tests, but it was found that while the portions of the 1902 specimens which had been reserved were of the same resistance as when first tested, the new specimens had to be reduced in size to ⅜ × ⅜ × 6 ins. before some of them could be ignited and made to burn. It was deemed best, therefore, to make cob houses of pieces of this dimension for all further tests.

Accordingly, cob houses were made of such samples as were large enough to permit it and exposed to the flame of a blast lamp or large Bunsen burner. The time needed to set the pile on fire permanently was taken, the height of the resulting flame, the time before the burning of the pile sufficiently to cause it to fall, and the condition of the embers at the time of falling. Omitting a number of minor observations which might have been followed up had the time and material at hand been greater, it is evident from an examination of Table II. that the untreated wood ignites much more readily than the treated woods of all kinds. And, second, that when once ignited it burns more readily and freely, with more heat, than any of the treated woods.

Excepting those tests in which it is stated that the blast lamp was used, a Bunsen burner was applied to light the wood. The blast lamp is no hotter than the Bunsen but it burns a larger volume of gas, and gives a larger flame. Although for the sake of comparison the burner was left under the untreated wood for three minutes, it was found that the wood was ignited by an exposure of from three to ten seconds.

TABLE II.—Showing Results of Cob House Tests of Fireproof Wood.

No.	Process	Kind	From	Ignited in mins.	Height of flame, ins.	Minutes before falling	Remarks
148	American	Mixed	Manufacturer	3¼	6	8½	Blast lamp
152	Fireproofine	"	"	3 1/6	6	Jarred	Blast lamp
153	Electric	"	"	No flame	0	0	Blast lamp, after exposure for 11 minutes pile smoldered for 10 minutes
154	Electric	"	"	8	2	28	Smoldered
155	Fireproofine	No. 11 mahogany / No. 2 Oak	New York building	3	6	Indefinite	
156	Fireproofine	No 14 Oak	"	3	28	11½	Burned fiercely
157	Untreated	Mahogany		1/6	36	5	Consumed
159	Untreated	Ash		1/6	36	6	Consumed
160	Electric	Mahogany	Manufacturer	6½	4	Indefinite	Burned out slowly
161	Untreated	Oak		¼	36	4	Consumed
162	Fireproofine	Oak	"	5½	4	Indefinite	Burned slowly
163	American	Mixed	"	3	15	17½	Consumed. Strong fire
164	Electric and Fireproofine	Nos. 6, 14, 15 / Oak	New York building	3	12	18	Consumed in large part

Examination of the table will show that one cob house, No. 153, of mixed woods of the Electric company failed to ignite even after eleven minutes exposure to the flame of the blast lamp. It smouldered and extinguished itself after ten minutes. A second cob house of the wood of the Electric company, No. 154, also mixed, but largely mahogany and oak, with no soft wood, failed to catch until after an exposure of 8 mins. It then burned with a flame of little vigor but with considerable glow of the embers until 28 mins. after the start. A third cob house of the Electric company, No. 160, wholly of mahogany, caught fire at the end of 6 mins. and 20 secs., and burned with a flame of a maximum height of 4 ins. In no one of these tests was there the yellow flame of an ordinary wood fire, but a blue flame of little substance.

The cob house, No. 162, of fireprofine oak caught fire in 5 mins. and 20 secs. and burned with a flame of a maximum height of 4 ins., and did not fall but settled down until practically all consumed, though burning with little vigor. The cob house, No. 152, of mixed woods of the Fireprofine Company caught in 3 mins. and 20 secs. and burned with a flame of a maximum height of 6 ins., until it was accidentally overturned.

The cob house, No. 148, of the American company was ignited in 3 mins. and 20 secs. and burned with a flame 6 ins. high for 8½ mins., while No. 163 of mixed wood from the same company caught fire in 3 mins. and burned with considerable vigor for 17½ mins. with a maximum flame of 15 ins.

This completes the list of cob houses made of wood sent us by the manufacturers, and because of the smallness of the samples and the fact that at the beginning of the test I had no means of knowing the maker of any of the samples taken from buildings, there is insufficient data as to the relative merits of the wood of the different companies as shown by these pieces. It was necessary to put together several lots, for instance cob house No. 164 was made of oak of the Fireprofine company and the Electric company as well. All the remaining cob houses were made largely of the wood of the Fireproofine company, and it should be noted that the cob house No. 156 composed of oak acted in no way different from untreated wood, except that the flame was slightly less in height but full as hot, with all the appearance of wood flames.

In general the wood sent by the manufacturers was better than that taken from the buildings, but not enough so to even suggest that the samples sent us by them were not representative of their best every-day practice. A cob house made of the wood sent in 1902 by the Electric company burned much as it did when tested at that time; if there is any difference it makes a better showing now. In the meantime it has been stored on a high shelf in the basement of the Walker Building.

FLUE TEST.—The effectiveness of the protection afforded by the treatment when applied to somewhat larger pieces was shown by the flue tests. Boxes or flues 4 ins. square and about 30 ins. long, open at both ends, were partly filled with shavings and chips of fireproof wood, and placed on end upon a fine grate. On applying a flame to the lower side of the grate the fireproof kindling became ignited and the resulting condition of flame and charring are shown for a number of specimens in Table III.

The boxes of untreated wood burned with flame of such volume that it endangered the hood under which the tests were carried out, and water had to be thrown on the wooden supports back of the Uralite sheeting. The boxes Nos. 123 and 149, made of stock taken from buildings, burned with more readiness than did the similar specimens from the manufacturers direct. One, at least, of these pieces had never been treated with anything except oil or varnish. Boxes Nos. 151, 167, 168 and 169, all of wood direct from the factories, were igniting with difficulty and burned with little or no flame until, after having charred up some distance on the inside of the box, the fire went out. In tests Nos. 121, 123 and 124 the blast flame was used and the air blast was applied from time to time to increase the fire if possible. In the remaining tests the Bunsen flame was used. The results of these tests upon larger pieces show that it is with difficulty that the thoroughly treated wood can be made to support its own combustion, and that the danger of spread up a vertical surface is not nearly as great as with untreated wood.

KINDLING TEST.—If a pile of small bits or blocks of any of the brands of fireproof wood be placed upon a fine grate and enclosed with four bricks, it will be found that there is little difficulty in igniting this "kindling" and causing it to burn with slight flame until all consumed. It makes a hot fire, much like hard-wood charcoal.

EXPOSURE TO DAMPNESS.—One of the most serious objections to fireproof wood in the minds of many who have used it is the difficulty of preventing the salts used in the treatment from injuring the appearance of the varnish, especially in damp places. Of the several samples sent us from actual service only one was free from this trouble, and that one had manifestly never been "fireproofed." Several pieces of fireproof wood placed in damp locations have shown a tendency to mold and effloresce, but it does not appear that their fire-resistance has yet been materially diminished. In damp places the contact with fireproof wood increases the rate at which rusting of iron occurs, but for use in dry places there need be little apprehension on this point.

CONCLUSIONS.—In the report of 1902, I drew this conclusion:

> In the light of these experiments it would not appear that more can be claimed for fireproof wood than this: That when heated it gives off a gas which makes it more likely to fail to keep burning than an untreated piece of wood; and that, when afire, it gives out less flame and hence is not as likely to cause fire to spread. It is not incombustible; it is not uninflammable; it is a good fuel; it will under many conditions support its own combustion; it is destroyed by external heat nearly as fast as is untreated wood.

All this is as true now as it was then, but in view of the altered claims of usefulness of the makers and the material improvement in the resistance of much of the material now submitted when compared with the specimens tested at that time, I feel that a further statement should be made.

Judged by the average of all the specimens examined it is clear that many sources of ignition which, while lasting only a few seconds would set fire to untreated hard wood, must last at least five minutes to set fire to fireproof wood. The flame and radiation given off by fireproof wood is only a small fraction of that given out by untreated wood, and the chance of spread of fire along it from the heat of its own burning is almost nothing. The deterioration of the wood when kept in a reasonably dry place is shown by the specimens of the Electric company at least, to be almost nothing for a period of three years, and it is my opinion that when painted or varnished or even when, like the specimens which were kept for examination in 1902, they are in the shape of rough lumber, the protection of the Electric process is apparently permanent. No information is at hand, unfortunately, concerning the other processes, on this point.

As has been said, the material taken from the buildings was, on the average, poorer than that sent by the manufacturers, but there were a number of pieces which were quite as well treated as the best sent by the makers. The best and the poorest pieces of the old material came from the same building and was represented to us as being the product of the same company. This calls attention to the difficulty of determining the quality of the material except by destroying it, and makes it seem that the best guarantee of quality must finally be found rather in that the product is the work of some firm or number of firms whose name and brand carries with it absolute protection as to its reliability, rather than to attempt a test any large percentage of it. There has been an uncertainty, apparently based upon experience, among the building trades as to the quality of the material which they have purchased under the name of fireproof wood, that has hindered the use of it greatly, and that there is some basis for their suspicions is shown by the specimens examined. It seems unlikely that much unsatisfactory wood has gotten by the Building Department if we may judge from these pieces.

It was noted all through the tests that the fumes of the burning wood were intensely pungent, irritating to eyes and throat, and caused in the case of a number of persons exposed to them for some days acute illness for a short time. In case of fire, it is probable that the firemen would find this smoke a hindrance in entering and working in a building trimmed with fireproof wood. The relative effectiveness of the treatment in use by at least one of the companies in 1902 and in 1905, shows that the art has progressed, and that the later specimens are more fire-retardent than the earlier ones were when new, or are at this time.

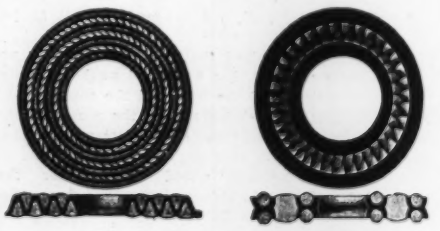
I cannot question the value of the best of the fireproof wood here represented by the product submitted by the makers and taken from actual service for the trim of so-called fireproof buildings, and many similar uses, where the added safety from ignition from slight causes is a safeguard to both life and property.

TABLE III.—Showing Results of Flue Tests of Fireproof Wood.

No.	Process	Ignited in mins.	Maximun flame, ins.	Fell in mins.	Remarks
121	Electric	13	24	60	About one-third consumed
123	Fireproofine No. 16 and No. 2 Oak	8	20	40	Wholly consumed
124	Untreated Ash	5	36 to 40	25	Wholly consumed
149	American Mixed	3	25	40	60% consumed
150	Electric Oak and Fireproofine Mahogany	9½	18	61	50% consumed
151	Electric Mixed	(?)	None	....	Lower end charred only. Rest intact
165	Untreated Mahogany	¼	48	Extinguished with water	Burned fiercely
166	Untreated Maple	¼	36	Extinguished with water	Burned fiercely
167	Fireproofine Mixed	7	Slight	Out. Did not fall	Lower end charred for 18"
168	Electric Mixed	7	Slight	Out. Did not fall	Lower end charred for 12"
169	American	7	Slight	Out. Did not fall	Lower end charred for 18"

A NEW FORM OF ELASTIC METAL GASKET FOR HIGH PRESSURES.

The accompanying illustrations show two forms of copper gaskets for high pressure steam pipes. These gaskets are made in all sizes from a fraction of an inch to, in special cases, several feet in diameter. As will be seen from the drawings, the gasket consists in one case of a sheet copper ring with circular corrugations filled with asbestos and in the other case of concentric copper rings separated by an asbestos ring, and having asbestos cords set into grooves on both sides.



Gasket for High-Pressure Steam and Air Pipes.

The advantages claimed are that the steam fitter has, in place of a plain copper gasket, which has to be packed with mineral wool or asbestos fiber, in one piece a gasket already packed with asbestos in condition for immediate use. These forms of gaskets have been extensively used in Germany, and were also employed throughout the power plant installation at the Louisiana Purchase Exposition. The gasket is handled by Frederick Goetz, 723 East 141st St., New York City.

STEEL PILES are being used to line some of the foundation wells for the new Brevoort Hotel, Chicago. Ordinarily these wells are excavated in 5-ft. "lifts," and lined with vertical wooden lagging braced by inside steel hoops. Owing to the soft clay at this site, however, it was feared that with a 5-ft. depth unlined, some movement of the clay might occur which would affect the foundations of adjoining buildings. The wells are 5 ft. diameter, and the piles for each well are driven until they form a complete cylinder extending 30 ft. to the hard formation beneath the clay. The clay within the cylinder is then removed and concrete filled in to form the foundation pier. The piles are made by the United States Steel Piling Co., of Chicago, and one of the form illustrated in our issue of Sept. 29, 1904. Each pile is a single rolled shape, with a flat web having a solid bulb along one edge and a hollow socket along the other edge. The bulb of one pile fits into the socket of the next pile, forming an interlocking joint, and the joint can be made watertight by driving a wooden strip to fill the open part of the socket.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
SAN FRANCISCO: Rialto Building
BOSTON: 170 Summer Street
ATLANTA: Austell Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

SUBSCRIPTIONS

United States and Possessions, Canada, Mexico and Cuba, One Year, $5.00.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00. (£1-18-0).
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $5.00. 21 Shillings, 25 Francs or 21 Marks.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter. Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Receipts for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year, and the one or two preceding figures the week of that year. 52-5 means the 52d week or December 28, 1905.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See pages 28 and 27.
Copy for regular, or "Contract," Advertisements should be received one week before publication; "For Sale" and "Situations Wanted" Advertisements by Tuesday, and "Proposal" and "Situations Open" Advertisements by 11 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

The Jury of Award has rendered its report upon the papers submitted in competition for the prizes offered by Engineering News and "The Cement Age" for the best papers on "The Manufacture of Concrete Blocks and Their Use in Building Construction." As most of our readers will recall, a first prize of $250 and a second prize of $100 were offered by us last March for the best papers on the above subject from 5,000 to 10,000 words in length, the competition to close on July 31. All papers were to be signed by a nom de plume and accompanitd by a separate sealed envelope with the name and address of the author, these envelopes to remain unopened until the jury's report was rendered.

Twelve papers were received by us in competition for the prizes. In accordance with the conditions of the prize offer, a preliminary selection was made by the editors of Engineering News and the five papers which were deemed the best were submitted to a jury of award composed of Messrs. Robert W. Lesley, Past-President of the American Cement Manufacturers' Association; Richard L. Humphrey, President of the Cement Users' Association; and Prof. Edgar Marburg, Secretary of the American Society of Testing Materials. The five sealed envelopes containing the names of the authors of these five papers were placed in the hands of Mr. Charles Warren Hunt, Secretary of the American Society of Civil Engineers, and the award of the jury was transmitted to him when received. The jury's award and Mr. Hunt's announcement to us of the winners of the competition follows:

To the Editors of "Engineering News" and "Cement Age."

Sirs: The jury charged with judging the papers on "The Manufacture of Concrete Blocks and Their Use in Building Construction" met on the 16th day of September, 1905, and reached the following unanimous decision as to the merits of the five papers submitted to them for examination:

1. Jan J. Jansan.
2. Disinterested Investigator.
3. Crete.
4. Americanna.
5. H. B. Konkrete.

The jury desires to state, however, that, in their judgment, the paper to which the first prize is awarded is notably faulty in the omission of illustrations, and, perhaps, in a lesser degree, in the absence of adequate reference to the patent literature on the subject.

The most serious defect of the second paper, by "Disinterested Investigator," in the opinion of the jury, is the lack of sufficiently detailed information concerning the practical features of the cement block industry, and the relatively large space given to the discussion of patent literature.

All of the papers submitted contain statements of opinion to which the jury is unable to subscribe. The prize papers are, however, distinctly less open to this criticism than the others.

Respectfully submitted,
R. W. Lesley.
Richard L. Humphrey.
Edgar Marburg.

Philadelphia, Sept. 16, 1905.

Editor Engineering News:

Sir: I have opened the five sealed envelopes, and find the names of the competitors whose papers were submitted to the Jury of Award in your prize competition for the best paper on concrete blocks to be as follows:

Nom de plume.	Name of author.
1. Jan J. Jansan	H. H. Rice, 312 Century Bldg., Denver, Colo.
2. Disinterested Investigator.	Wm. M. Torrance, Asst. Engr. in Charge of Concrete-Steel Design, Hudson Companies, 111 Broadway, N. Y. City.
3. Crete	H. G. Richey, Supt. Cons., U. S. Public Buildings, Evanston, Wyo.
4. Americanna	Noyes F. Palmer, Pres. Noyes F. Palmer Mfg. Co., 150 Snedeker Avenue, Brooklyn, N. Y.
5. H. B. Konkrete	U. G. Hayne, Fort Stevens, Oregon.

I return herewith report of the Jury of Award as requested, and am,

Yours truly,
Chas. Warren Hunt,
Sept. 22, 1905. Secretary Am. Soc. C. E.

The paper receiving the first prize is printed, in full, in this issue of Engineering News, and the second prize paper will follow next week. Subsequently we shall publish such portions of the other papers submitted in the competition as contain matter of interest not included in the prize papers.

A word as to the outcome of the competition seems worth while, and is at least pardonable now that the work of examining the papers is concluded and judgment has been rendered. It was in great measure a venture on the part of the prize givers to inaugurate this competition; concrete blocks had only recently been extensively used as a building material; their manufacture was a new industry widely scattered and marked by individually insignificant capital investments; the men who had taken the work up were not engineers, and certainly not text-book writers, and there was no literature or body of accumulated information on the subject to which the writer could go either to instruct himself or to prepare instruction for others. Information being obtainable only from the actual maker of concrete blocks it was necessary to induce him to talk, and the most practicable method of succeeding in this seemed to be to offer to pay him for talking on such a basis as to encourage him to talk his best. Hence the offer of money prizes. What the success technically of the plan has been may be left to our readers to judge, as the results are spread before them in this and succeeding issues of Engineering News. We can truly say that to ourselves the contest has been no surprise. The number of papers, while not large, showed clearly the wide field of interest in concrete blocks; Boston, Mass., Denver, Colo., Des Moines, Iowa, Marion, Ohio, Atlanta, Ga., Kansas City, Mo., New York, N. Y., Evanston, Wyo., and Fort Stevens, Ore., are the towns and cities represented by their writers. The character of the papers is, throughout the list, essentially practical; they were the work of persons who had had their knowledge wrought out by the hard knocks of success and failure in the commercial production and use of concrete blocks. Knowledge of this sort is valuable, but as it is often gained in narrow fields bounded by local conditions it has of course to be interpreted broadly and wisely not to be misleading. A notable feature of the papers was the absence of the professional writer and teacher from the contest; nothing shows better than this fact the truth of the theory on which the competition was invited, namely that there did not then exist, even the beginnings of a technical literature on the subject. Since our prize offers were made the conditions in this respect have changed somewhat. The Cement Block Manufacturers' Association has been organized and held a convention at which a number of papers on concrete blocks were read and discussed. A number of independent writers have also made concrete blocks the subject of articles of varying value contributed to journals devoted to carpentry and building. These scattered papers with the prize papers which we have in hand comprise the bulk of the existing literature on concrete blocks and their use in building construction. In a succeeding issue we shall consider the broad lessons to be drawn by the manufacturer and user of concrete blocks from the data available in these scattered papers, but for the present we shall simply urge that our readers make themselves familiar with the information given in the papers themselves the first of which is published in another column.

Tunneling through soft material in the heart of a city where numerous tall and heavy buildings exist, and where many of these buildings have spread foundations practically on the surface of this material, is a delicate kind of work which has been successfully prosecuted in Chicago for about five years, with practically no trouble from settlement of the ground. A change from the original plans, by which the tunnels have begun to be carried under the buildings as well as under the streets, has caused trouble, however, and within the past few months settlements of streets and buildings have occurred, with the result that the effect of city tunnel construction upon the foundations of buildings has been made the subject of expert investigation. The Chicago tunnel system which was built as a telephone conduit and is now proposed as a means of freight transportation, forms an intricate network under the streets of the downtown district and now comprises about 33 miles of concrete-lined tunnels, 6 ft. wide and 7½ ft. high inside. The system has been under construction since 1899, but it is only within the past few months that settlements have been noted, and as a result the Commissioner of Public Works appointed a committee of engineers to investigate the cause. Their first report was published in our issue of Aug. 24, and stated that no settlements had occurred where the main tunnels had been built under air pressure, but that they had occurred where connections or spurs had been built without the use of air pressure. The Commissioner then called for a more detailed report, which we publish in another column, and this not only records specific instances of settlement but shows that a serious problem now faces the tunnel company. The main tunnels are built in the Chicago clay and at a depth of about 20 ft. from the street surface to the crown of the tunnel; as they are located under the center lines of the streets they are clear of the lines of pressure from the buildings, and are subject only to the pressure due to the overlying material. At street intersections the tunnels also have intersections, and the two lines of straight tunnel are in many cases connected by four curved tunnels forming a double Y. This, of course, involves the removal of a great mass of material, and unless the work is prosecuted very carefully there is liable to be a slip or movement of the clay. The construction of one of these intersections without sufficient care and precaution is given as the cause of one of the street settlements already referred to.

But a much more serious matter is that of tunneling through clay subjected to pressure from neighboring buildings. As long as the tunnels were to be used simply as conduits for electric wires and cables, there would be very little of this class of work; but when their use for transportation purposes was planned it was proposed to build lateral branches and spurs to serve post offices, newspaper and express offices, railway passenger and freight stations, wholesale and retail stores, warehouses, office buildings, etc. These spurs would enter the basements of modern buildings having deep basements, while in other cases they would connect with shafts having elevators to serve the building above. The construction of these connections must involve the excavation of clay under various degrees of pressure from the buildings, and when any void is left, however small and if only temporary, the clay will fill in and the movement of the clay body may extend for considerable distances. This feature of ex-

cavation work in Chicago was discussed in an article on Chicago foundation works in our issue of Dec. 22, 1904. The engineering committee considers that the tunnel company has undertaken the construction of these branches without having given sufficient consideration to the special conditions affecting this phase of its work, and recommends that no more such branches should be built until the special conditions in each particular case have been carefully studied and a proper course of construction planned. Whatever care is taken, however, some settlement is considered unavoidable. The use of compressed air will not suffice to sustain the material, and, in fact, its use in this part of the work is not considered practicable by the committee. The soil under pressure must be supported by mechanical means, and it is pointed out in the report that the case "is a building proposition, and the methods common in building practice will probably meet all the difficulties that may be encountered." The committee has also recommended the adoption of a circular section for the spurs and branches instead of the horseshoe section of the main tunnels. The success of the tunnel system for transportation service depends upon the existence of these numerous lateral connections, and there is no doubt that the engineers will proceed to devise special plans and methods for their construction. Up to the time of the present investigation the tunnel company had been given a free hand, and the city had not exercised any supervision over the work of construction, but in future this work will be subject to the approval and supervision of engineers representing the city, which is of course eminently proper.

Judging by reports relating to the Japanese army in the late war with Russia we may expect to see Japan leading the world in the practical applications of the teachings of sanitary science. Perhaps the most striking thing yet reported was told before the convention of Military Surgeons at Detroit on Sept. 27. In the course of an address at that time and place Surgeon-General S. Suzuki, of the Japanese Navy, made the following statement:

> Much of our success in the treatment of wounds I ascribe to the fact that, before every engagement, I ordered each member of the crew to bathe and put on perfectly clean underclothing. In a great many shot wounds fragments of clothing are carried into the body, and our insistance upon clean underclothing prevented many cases of blood-poisoning among our wounded.

It is reasonable to expect that a nation that takes such sanitary precautions during the strain and excitement of an infrequent war will not be unmindful of far greater possible saving of life day in and day out among its city dwellers through a like observance of sanitary laws.

It is common enough to hear those who are in charge of engineering work declare that "time is the essence of the contract," and to see them endeavor by every possible means to secure rapid prosecution of work; but the problem which seems difficult of solution is how to hold a contractor in sufficient penalties to compel him to do rapid work. Penal clauses in contracts for delay in completion are generally frowned upon by the courts.

A case in point has just been tried in New York City in connection with the contracts for the cables of the Williamsburg bridge, which were built by the Roebling Co. The contract for these cables contained the following clause:

> Paragraph J.—And the said party of the second part [the Roebling Company] hereby further agrees that the said parties of the first part [the Bridge Commissioners] shall be, and they are hereby authorized to deduct and retain out of all the moneys which may be due or become due to the said party of the second part under this agreement, as liquidated damages for the non-completion of the work aforesaid within the time herein specified for its completion, or within the stipulated time to which the same may be extended in writing by said commissioners, as herein provided, and not by way of penalty, the sum of $1,000 for each and every working day the time consumed in the execution of the work may exceed the time stipulated for its completion, or such stipulated time to which the same may be extended by said commissioners as aforesaid, which said sum of $1,000 per day, in view of the difficulty of estimating such damages, is hereby agreed upon, fixed and determined by the parties hereto as the liquidated damages that the said city will suffer by reason of such default, and not by way of penalty.

In accordance with this provision in the contract, Bridge Commissioner Lindenthal imposed a $1,000 a day penalty as soon as the contract time expired and deducted this sum from the payments. The Roebling Co. brought suit against the city to compel payment of this amount, and the case was tried before Hon. Alton B. Parker as a referee. In the course of the trial it was shown that the bridge could not have been used any sooner had the cables been completed at an earlier date. As a matter of fact, there was long delay in opening the bridge for traffic after its completion through failure to complete arrangements with the street railway companies for crossing the bridge. Evidently, therefore, the city did not actually suffer $1,000 a day damage through the mere delay in completing the cables, and hence the collection of any such sum would have actually been a penalizing of the contractor, which the courts have uniformly refused to uphold.

In Judge Parker's finding in favor of the contractor, moreover, he points out that

> There is nothing in the contract which says the commissioners are clothed with power to determine whether there was any delay on the part of the plaintiff.

This may appear to be only a technical defect in the contract; but it is nevertheless a fatal one, so far as the successful collection of damages for delay in completion of the contract was concerned. It well illustrates the care and legal ability necessary in framing a contract if the party undertaking the work is to be effectively held responsible for rapidity of prosecution.

CONCERNING THE WORK OF THE STREET RAILWAY CONVENTIONS.

The Philadelphia convention of the American Street Railway Association, held last week, brought forward some matters of interest in connection with the conduct of the affairs of technical or semi-technical societies. The successful exhibition of street railway appliances at Philadelphia, which was almost more important, and certainly more interesting, than the convention itself, gives much support to the argument for holding such special exhibitions in connection with conventions of the special societies most closely related to the respective subjects. But the important proviso may not be lost sight of, in making such argument, that the exhibition must be well managed. The exhibition business is very easily overdone. Not to speak of universal expositions, which the St. Louis fair has put to sleep for probably many years to come, even special exhibitions may easily become too frequent or inordinately expensive for the exhibitors, or not representative, or otherwise fruitless. Yet when suitably conducted, in charge of those who have vital interest in their success, they are of much value to both exhibitor and visitor. The exhibit at the recent International Railway Congress at Washington, D. C., is a good example.

The street railway exhibition owes much of its success, no doubt, to the arrangement under which this year and in future the exhibitions at the meetings of the American Street Railway Association are managed entirely by an organized body, the Manufacturers' Association, distinct from the main association. This plan has been followed for ten or a dozen years by the Master Mechanics' and Master Car Builders' Associations, at whose conventions there is always an elaborate exhibition, conducted by the Railway Supply Men's Association. The success of the plan may be interpreted as a natural consequence of assigning the work of management to those most vitally concerned in the exhibition.

The reorganization of the American Street Railway Association was another instructive feature of the Philadelphia convention. It has created, or will create, a closely-bound group of societies, at present four, in which one is in controlling (or, if need be, even dictatorial) relation to the others. The controlling society will be composed of corporations (represented at the meetings by one or more of their executive officers), and will have the purpose of discussing anything that may appear to concern the conduct of street railway companies. It will maintain a year-round activity by having a permanent secretarial bureau, which may collect and distribute information and perform similar functions. The president's address at Philadelphia, in a strongly-worded section devoted to municipal ownership, intimated that propaganda against this and similar "heresies" would be an important feature of the bureau's work. Presumably such matters as relations between employees and labor organizations and the [illegible] of legislation desired or opposed by the street railway companies will also be taken up. The expressions of President Ely are to be taken as those of the Association, the latter would have used this bureau as a means of fighting what he called the "free-silver heresy," has its real bureau existed in 1896 and 1900. Thus, the work of the Association will not confine itself to business features of street railway operation, but will include as an important part the cultivation of political ends with no apparent relation to progress in electric railway engineering. The association will in consequence be a commercial league rather than a technical society. In this light the reorganization plan, as put through at Philadelphia, and the resultant domination of the individual street railway societies by the society of the executives, merit some consideration.

The main features of the reorganization are: 1. Assessment of dues upon the active or company members of the American Street Railway Association according to their annual gross earnings (with, however, only one vote for each company). 2. Supplying from the Association's income the principal part of the funds needed to conduct the work of the affiliated societies. 3. The issuance of charters from the Association to the affiliated societies, in such form as to give the Association close and effective control over the work of such affiliated societies, in particular by requiring the constitution and by-laws (and amendments) of these societies to have the approval of the Association, and by enabling the Association to withdraw its financial support when the work of any society is not satisfactory to the Association. 4. The management of meetings of the affiliated societies by the Association. 5. The editing and publication of the societies' papers and proceedings by the Association, which service, like the other financial assistance, may, however, be withdrawn from any society when its work becomes unsatisfactory to the Association.

This arrangement gives to the affiliated societies several valuable advantages. It opens to them a source of funds for conducting needed work on a much larger scale than they could themselves afford. The petty drain of annual dues and assessments is removed from the private purse of the bookkeeper, the master mechanic and the station engineer, where it does not rightfully belong, and put upon the company's exchequer, where it does belong. Collectively and individually, the societies and the Association have the advantage, under the new publication arrangement, of finding the proceedings of all the component bodies in the covers of a single volume. These advantages might, evidently, be attained equally well under other forms of organization. But, as they came to the street railway societies only with the present reorganization, the latter may well be given credit for making them possible.

The bad feature of the arrangement is the large possibilities, which it contains, of mischievous interference by the Association in the work of the affiliated special societies. In general terms, the form of reorganization creates a relation of superior and inferior, of dictation and compliance, which must be harmful to the inferior society and can in no evident manner benefit the controlling organization. The effects are broadly the same as in the case of an inspired or prejudiced press, or of a public officer who has tenure at the absolute will of a political boss or coterie. Of the several affiliated street railway societies we are here interested more particularly in the engineering society, the organization hitherto known as the American Railway Mechanical and Electrical Association, which is intended to bring together the engineering interests concerned in street railway work. The subjection of such an organization to an arrangement as described will create the first recorded case of an engineering society—a society with large possibilities before it—existing in a state of dependence upon the dictates of a commercial body.

If some specific instances be considered—though it is impossible to state in advance of actual trial all the possible, or even the most

probable, instances of retrogressive or vicious interference—the undesirability of such a condition of villeinage in the case of the street railway engineering society can be more clearly understood. Suppose the Association chooses to exercise its control over the society in such a way as to limit its membership. If the representatives of one or more municipally-owned street railways should desire to join this society, the Association, with its violent opposition to the municipal ownership movement, would be able to absolutely bar these applicants from the society. The society would at once become unrepresentative; what doubt but that the street railway art would correspondingly suffer in its development? Or, should a reputable member of the society "lend his services to the enemy's cause" as by rendering a report on a system of municipal street railways; or should he in some other way incur the antagonism of the commercial and financial interests in the Association, what easier means for the latter to express its disapproval of the action than to compel his expulsion. Again, consider what might be done by manufacturing interests, through control of the Association, to fight competing interests. The electrical side of street railway equipment being almost exclusively in the hands of two companies, with many interests in common, and both engaged also in street railway operation, these companies undoubtedly can exert a considerable influence in determining the actions of the Association. If now any serious threat of competition should arise, it could be discounted by properly-planned "standardization" and similar action by the engineering society. Is it unreasonable to suppose that this might be attempted?

The possibilities of mischievous interference by the controlling Association, in the affairs of the subsidiary societies are most serious in the case of the engineering society. The societies of the accountants and the claim agents are no doubt also liable to be injuriously affected by the guardianship of the Association, but probably in a very much smaller degree; apart from degree, moreover, such interference does not concern us here, as our interest centers in the relation of the question to engineering work.

The art of electric traction is advancing and developing as rapidly to-day as ever; vast as it is in the magnitude and variety of its problems, it looks forward to larger work. Above all, the art is in the early part of a new epoch, an engineering epoch, in which the practice of laying out electric railways by compiling from catalogues will no longer be known. The Street and Interurban Railway Engineering Society, as it may perhaps be called, has the promise of the leading part in facilitating and recording this advance in detail. If the present reorganization shall act to hamper its assumption of that part, the executives' Association will not be the last to regret the fact. We trust that, when the details of the reorganization are fixed by the adoption and approval of the engineering society's constitution and by-laws, it will appear that proper provision has been made to assure independence, or, if that be impossible, at least a substantial measure of freedom, for the engineering society.

LETTERS TO THE EDITOR.

The Record of Speed in Shaft Sinking.

Sir: In your issue of Sept. 21, 1905, I notice an article on "Rapid Shaft Sinking at a Nova Scotia Coal Mine," by W. H. Hyde, Assoc. Am. Soc. C. E.," and also an editorial comment thereon. As I was engaged on those shafts in the earlier stages of their progress, and still take an interest in that work, I wish to call your attention to one fact in connection with the article, and to take exception to part of your editorial. The article mentions the work as "the deepening of an old shaft," whereas the shaft was not an old one, but started from the surface.

In your comment you mention the sinking of a shaft 6 × 21 ft. in section, in South Africa, 213 ft. and 6 ins., in May, 1903, as being the fastest shaft-sinking of which you have been able to find record. Compare the section of this shaft, 6 × 21 ft., with that mentioned by Mr. Hyde, 12 ft. 6 ins. × 24 ft., and note the great difference in the amount of "muck" which had to be excavated, also the depth of the hoist. You cannot, then, but admit that the Nova Scotia shaft holds the record for progress, even though the shaft in South Africa made a greater distance lineally.

Respectfully yours,
Herbert S. Patterson.

Uniontown, Pa., Sept. 27, 1905.

(Since the above letter was put into type word has been received that during September 113 ft. of shaft was sunk and 146 ft. of shaft timbered.—Ed.)

The Labor Problem in the South.

Sir: I have read with much interest, in your issue of Sept. 21, the statements of Mr. J. N. Hazlehurst on the labor situation in the South, and your editorial comments on the same. While bearing the same name, I have never met Mr. Hazlehurst, yet a large experience with work in the South for the past seven years enables me to confirm every statement made in regard to negro labor, and its entire unreliability and scarcity.

In the later part of 1898 I was connected with a large water power development in Georgia. The negro labor was paid 75 cts. per day, and was worked from sunrise to sunset. Early in 1899, to hold the men, the hours of work were reduced to ten per day, the pay remaining the same. By the later part of 1899 the wages had risen to $1 and then $1.25 per day of ten hours. In 1900 wages had risen from $1.25 to a limit of $1.35 per day. At no time was it possible to increase the output of work, by shortening the hours or increasing the wages. The number of men was increased, but the product per man was decreased.

From 1900 to 1905 wages have generally risen all over the South, and labor has become scarcer and more unreliable. During this year the writer has known wages of $1.50 and $1.60 per day being paid, without producing results in attracting and holding labor. At the present writing, on one water power development with which the writer is connected the superintendent does not know the evening before the force that will report for work the next morning; he has to reorganize each day for the day's work.

My observations have established the fact that the negro is content with from $2.50 to $3 per week. This amount provides the wherewithal for the necessaries and pleasures of life. If he is paid 75 cts. per day, three to four days' work can be obtained from him; if paid $1 per day, a maximum of three days only can be obtained, and a further increase in wages, produces a decrease in his labor.

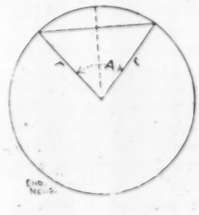
The labor problem is the most serious one confronting the South to-day, and the people understand its significance and may be relied upon to solve it in time. There can be no doubt that the material progress so well started and under way is being seriously handicapped by the utter unreliability and retrogression of the negro population.

Yours truly, George B. Hazlehurst.

Catonsville, Md., Sept. 23, 1905.

A Table for Finding the Length of One Side of Any Polygon Inscribed in a Circle

Sir: I have not been able to find a table like the one given below in any handbook, and as it is of great value to the draftsman, I worked it out according to the following simple reasoning.



Let n be the number of sides of the polygon or the number of parts into which we wish to divide the circumference of the circle of radius r by inscribing the polygon. Then the angle $A = \frac{360}{n}$. The length of the chord is $2 r \times \sin \frac{1}{2} A = D \times \sin \frac{1}{2} A = D \times \sin \frac{1}{2} \frac{360}{n} = D \times \sin \frac{180}{n} = D \times S$. The table was worked out to five places, although three places is near enough for most work. The figures have been carefully checked.

Yours respectfully,
C. L. Bogert.

313 Trenton Ave., Wilkinsburg, Pa., Sept. 19, 1905.

Table for Finding the Length of One Side of Any Polygon Inscribed in a Circle, from a Triangle to a 50-Sided Figure.

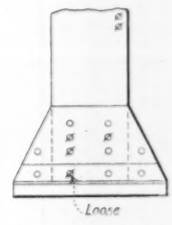
Length of Division = Diameter × S. $\left(S = \sin \frac{180}{n}\right)$

No.	S.	No.	S.	No.	S.
3	.86603	19	.16460	35	.08964
4	.70711	20	.15643	36	.08716
5	.58779	21	.14904	37	.08481
6	.50000	22	.14232	38	.08258
7	.43388	23	.13617	39	.08047
8	.38268	24	.13053	40	.07846
9	.34202	25	.12533	41	.07655
10	.30902	26	.12054	42	.07473
11	.28172	27	.11609	43	.07300
12	.25882	28	.11197	44	.07134
13	.23932	29	.10812	45	.06976
14	.22252	30	.10453	46	.06824
15	.20791	31	.10117	47	.06678
16	.19509	32	.09801	48	.06540
17	.18375	33	.09506	49	.06407
18	.17365	34	.09227	50	.06279

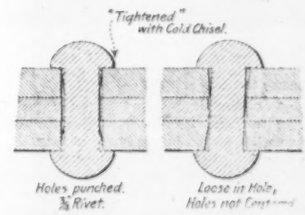
Is it Permissible to Calk or Sledge Loose Rivets in Structural Work?

Sir: I would submit to you the question of the efficiency of a riveted column made up of angles and plates, where eight rivets in the gusset plate connections were found to be loose and were tightened up by upsetting them with a cold chisel, effecting a tightening under the head, notwithstanding the fact that they were loose in the holes, so loose that they could be shaken.

The above method of doctoring up loose rivets I am told is generally practised out here in the local shops. Is this a good method or a safe one? And to what extent is the efficiency of the joint impaired? Also, is it the custom to doctor up rivets in this fashion in the eastern structural shops?



The accompanying sketches show the conditions as they were found in the present case. In the column base the four rivets shown crossed through were loose. The top connection of the same column had four loose rivets. The side connection had two loose rivets. The detail sketches of the rivets show how the looseness affected the seating of the rivets and how the rivets were "tightened." In some cases the hole in the middle plate was 14-16-in., in other cases it measured the required 13-16-in. (for ¾-in. rivets). The outside or punch side of the plate would measure from 15-16-in. to 1-in.



The superintendent of the shop where the columns were made up insists that this is absolutely up to the best practice of structural bridge shops in the east, and that the strength of the column is in no wise impaired. Would you kindly give me your opinion on this, and also submit the question for your readers' discussion?

Subscriber.

Seattle, Wash., Sept. 23, 1905.

(It is very common, so common that it may count as standard practice, to specify the workmanship in riveting structural steelwork about thus:

Rivets must be driven so as to be tight and to completely fill the hole. No calking or hammering of rivets will be allowed. Where rivets are found loose they must be cut out and replaced by new rivets.

Frequently this clause is found in immediate conjunction with a clause requiring the use of a power riveter of such construction that it can hold on its full pressure after driving. But there is no reason why the tight-rivet clause should be confined to power-riveting. The clause should, moreover, be independent of the occurrence of drilling or subpunching-and-reaming clauses. There may be a wide difference of opinion as to the desirability or necessity of securing rivet-holes absolutely true to size and in perfect alinement. But there can be no difference of opinion on the question of tight riveting, as this involves the basis of design by which the number of rivets is apportioned. Loose rivets, taken by themselves, are likely to be less efficient than bolts, for which latter a lower shearing and bearing stress is universally prescribed than for rivets. The difference usually made between shop and field rivets, in allowed stress, has in view the probable differences in alinement of holes and in non-uniformity of initial stress in the rivets due to the heating and riveting, rather than any looseness after driving that could be accepted in field rivets. We should not hesitate to affirm that good practice in all classes of riveting work should and does demand tight rivets, and cutting out and replacing all loose rivets. Work of the "doctored" kind here described must be characterized as unsafe. This is readily seen if an attempt is made to compute the rivet strength of the "doctored" connection. It is probably safe to assign a specific strength, though very much lower than that of well-driven rivets, to loose rivets, *provided* the whole connection is made up of loose rivets; in that case they would work ap-

proximately together, somewhat as the bolts in a bolted joint work together. But where a connection contains solid-driven and loose rivets intermingled, it is easy to see that the good rivets will carry virtually all the load, up to a deformation sufficient to bring the loose rivets to effective bearing by crushing them into seating. Generally such a deformation would not be reached until incipient failure of the sound rivets had been passed. Thus, such a connection is no better than if the loose rivets were absent, and is more dangerous than the latter, because it *appears* stronger.

Further comment by our readers will be appreciated.—Ed.)

Notes and Queries.

"Subscriber" writes:

A ton (more or less) fragment of a fly wheel fell at a distance of 200 ft. measured along level ground from its engine shaft. Seventeen ft. above the point where it buried itself in a concrete and hard earth floor, it passed through a flat roof leaving a clearly defined opening. From the center of this opening to the center of the mass, measured in a horizontal direction, was approximately 3 ft. Some of your readers may be interested to define the trajectory of the fragment and compute the speed of the fly wheel. Fragments no more than 1 ft. in length measured along the circumference, were picked up, showing clean fractures on radial planes; that is, similar to the meeting plane where two sections of a fly wheel are bolted together. The wheel in question was 18 ft. in diameter, 32-in. face, with a thickness of rim of 5 ins., reinforced by a central rib. It was in two sections bolted and it appears that the bolts themselves were not broken.

R. B. K., Pocatello, Idaho, writes: Can you inform me as to whether or not there is in use in the United States to any extent, any sort of device for killing weeds on railway roadbed, by sprinkling a liquid weed killer? Is there any liquid known that will kill weeds effectively, without injuring the ties or rail?

We know of nothing of this sort in the United States. A weed-killing tank car on the Guayaquil & Quito Ry. in Ecuador was illustrated in our issue of Aug. 11, 1904, and its use was described in our issue of March 2, 1905. The mixture used was composed of arsenical acid and nitrate dissolved in five to six gallons of water to the pound. About 1,600 gallons per mile were required to keep down the tropical vegetation.

On the Chicago, Milwaukee & St. Paul Ry. a weed burning car was used two years ago and was said to do effective work at a cost of only $2 to $5 per mile.

Mr. Hugh Leader, London, asks:

Can any of your readers oblige me by giving the latest and most reliable information on the subject of non-slipping staircase treads?

The well-known Mason lead-insert tread is, we believe, widely used. It is sold by the American Mason Safety Tread Co., of Boston, Mass. A lead-insert tread is also made by the Universal Safety Tread Co., of 45 Broadway, New York. The Universal people claim, we believe, that the Mason tread, as it wears down, becomes slippery, because the effective bearing surface is then formed by the smooth worn upper edges of the continuous retaining ribs (steel). The retaining ribs in the Universal tread are serrated to avoid this, but the Mason people claim that the serrations collect mud on a wet day. As far as our observation goes, both claim and counterclaim have some foundation. A tread similar to the Mason tread, but with carborundum in place of the lead, is sold by the Empire Safety Tread Co., of 299 Pacific St., Brooklyn, N. Y. It is claimed for this tread that the non-slipping surface never wears down. The same makers offer small cylindrical buttons, of carborundum, set in metal, which may be molded in place in concrete treads or concrete vault lights, to make them non-slipping. Further information relative to our correspondent's query will be appreciated. Simple cast-iron perforated or roughened-surface treads are not, so far as we know, a commercial article.

ANNUAL CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION AND AFFILIATED SOCIETIES AT PHILADELPHIA, PA.

The annual meeting of the American Street Railway Association and its three affiliated street railway organizations—the Street Railway Accountants' Association of America, the American Railway Mechanical and Electrical Association and the American Association of Street Railway Claim Agents—was held at Philadelphia, Pa., during the week of Sept. 25 to 30, 1905. Conjointly with this series of meetings, a large exhibit of street railway supplies was conducted by the "Manufacturers' Association of the American Street Railway Association." This exhibition was the central and characteristic feature of the convention. In inherent importance it was perhaps surpassed by the reorganization of the associated societies that was consummated at the convention. The technical work in the meeting was, on the other hand, of wholly minor interest and value.

The convention, that is the exhibit and most of the business sessions of the several associations, took place in one of the buildings of the Philadelphia Commercial Museums, south of the grounds of the University of Pennsylvania in West Philadelphia. The exhibition covered a space of some two acres on the ground floor of this building. The society meetings were held in a spacious but acoustically miserable hall on the second floor.

The individual societies divided the week between them after the following schedule of sessions: American Railway Mechanical and Electrical Association, four sessions, 10 a. m. and 1.30 p. m. of Monday, Sept. 25 and Tuesday Sept. 26. American Association of Street Railway Claim Agents, one session, 10 a. m. Tuesday, Sept 26 (Land Title Bldg.). American Street Railway Association, two sessions, 10 a. m. Wednesday, Sept. 27 and Thursday Sept. 28. Street Railway Accountants' Association of America, four sessions, 2 p. m. Thursday, Sept. 28, 10 a. m. and 2 p. m. Friday, Sept. 29, and 10 a. m. Saturday, Sept. 30. This schedule was followed with only minor variations. The week's program also contained several social or entertainment items: A reception by the local committee at the Bellevue-Stratford (the headquarters hotel), a theater party, a banquet, and a vaudeville entertainment.

The reorganization above mentioned is the result of a movement which has been active for several years past. The work of the American Street Railway Association had been going along in a rather purposeless and fruitless manner, and the potential energy of the annual convention was always dissipated largely in the preparation and exploitation of the customary supply-men's exhibition. As a result, many members of the Association felt that the time and expense required to attend a convention were not usefully expended. Conditions were made worse by the Association's practice of selecting the convention city only upon invitation from the local street railway company, upon which latter then fell the burden of making the local arrangements, providing entertainments, and the like. A year ago this practice was abandoned. A Manufacturers' auxiliary association was formed among street railway supply manufacturers and dealers, which with the approval of the American Street Railway Association took charge of local arrangements for conventions, and assumed the management of the exhibitions. The practice of locating conventions upon invitation then gave way to free selection of the convention city. The quantity and character of the work accomplished at the conventions were, however, not materially furthered by the change.

The interests which different street railway companies have in common are concerned partly with administrative, partly with legal, and partly with engineering problems. The first are handled by several departments, mainly by the executive and the accounting departments; the second are under the legal and the claims departments; and the last-named are principally under the engineering, construction and maintenance departments. As each class of problems is handled by different men, within a single company, it follows that a general street railway convention brings together several different groups of men each with interests more or less distinct from those of the others; in other words, such a convention consists of several conventions of distinct interests, each of which should, for best efficiency, meet separate from the others. This fact was recognized in practical form by the establishment of the Accountants', the Claim Agents' and the Mechanical and Way Men's associations, which, during their periods of existence of from two to ten years have by their work amply justified their foundation.

This system of working, however, with its resultant splitting up of payments for annual dues, the separate publication of papers and discussions, and other features, was felt by the executive departments, that is the railway companies themselves as represented in the parent association, to be too non-centralized. Moreover, it was felt that since the work of all the associations brought most benefit to the large companies and less to the small companies, its cost should be paid for in corresponding distribution.

The reorganization consummated at the Philadelphia convention has the purpose of attaining these objects. The principal element of the reorganization is the assessment of dues, upon the companies which constitute the active membership of the Association, in proportion to their annual earnings, and the payment, from this income, of certain sums to the affiliated societies. The dues vary from $15 for a company whose gross earnings are below $50,000 per year to $500 for a company whose annual gross earnings exceed $10,000,000. There may also be Associate Members, persons actively engaged in street railway work or otherwise deemed desirable associates, who are to pay $5 yearly dues. The payments to the affiliated societies are partly covered by an arrangement under which the Association undertakes to edit, print and publish the papers and discussions of the affiliated societies, and will in part take the form of contributions for conducting specific pieces of work. The affiliated societies are to exist under charter from the Association, with their constitution and by-laws subject to the approval of the latter, and must carry on their work in a manner satisfactory to the Association. Each society will elect one member of the executive committee of the Association.

The Association, under its new constitution, takes the name: American Street and Interurban Railway Association. Its objects are thus stated:

The discussion and recommendation of methods of construction, management and operation of street and interurban railways, and of safeguarding the interests of the same.

The establishment and maintenance of a spirit of co-operation among the members, and the encouragement of friendly relations between the companies and the public.

The acquisition of experimental, statistical and scientific knowledge relating to the construction, equipment and operation of street and interurban railways and the diffusion of this knowledge among the members.

It will have a salaried secretary appointed by the executive committee, and will maintain a permanent central bureau to collect and distribute information and otherwise serve the interests of the members.

The new constitution was adopted, by unanimous vote, by the American Street Railway Association, and the subsequent election of officers was conducted under the new constitution. President W. C. Ely (re-elected) thus is the first president of the American Street and Interurban Railway Association.

The program of papers of the various societies at the convention comprised the following:

AMERICAN STREET RAILWAY ASSOCIATION.—A short paper by Mr. Arthur West (Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.) entitled "Notes on the Design of Large Gas Engines with Special Reference to Railway Work," and a related paper on "The Application of Gas Power to Electric Railway Work" by Mr. J. R. Bibbins of the same company. The first paper spoke in very general manner about some constructional feature of large gas engines, such as the arrangement of cylinders to give an even distribution of power strokes, the requirements of accessibility to cylinders and valves, and the like. The paper of Mr. Bibbins presented a collection of performance results obtained in gas-driven railway stations, most of them working with producer gas. The influence of load factor was considered, especially in view of the small overload capacity of the gas engine (10% to 25%, depending on how it is rated). A diagram was shown, the result of calculations, exhibiting the relation between the cost of coal and the total cost of power from producer gas-engine and steam engine stations. The diagram shows that with coal costing more than $1 per ton, the gas station is the cheaper. The calculations appear, however, to base on rather uneconomical steam working.

A paper on "The Single-Phase Railway System" by Mr. C. F. Scott (Westinghouse Electric & Mfg. Co., Pittsburg, Pa.) summarized the features of series-motor single-phase railway operation, and then gave some remarks on work accomplished in the exploitation of the Westinghouse system. We quote this portion of the paper in full:

The single-phase railway which shows the most extensive operation as measured in car miles is that of the Indianapolis & Cincinnati Traction Co. Operation was begun over a short length of track Jan. 1, and on April 1

37 miles were covered. Since July 1 a regular schedule has been maintained over 41 miles, 37 miles of which is under alternating current trolley and the remaining 4 miles is under direct current trolley in the city of Indianapolis. The company has 10 cars, each equipped with four 75-HP. motors. A maximum speed of 60 and 65 miles per hour is secured and the cars are not only the heaviest but they operate upon the fastest schedule of any of the numerous suburban roads radiating from Indianapolis. Some defects have developed in the equipment which, however, have been incidental in character. It was found that the natural ventilation under the car was insufficient for the transformer and a ventilating motor was added. A weak point developed in the armature insulation when the cars which had been running for some time by alternating current were first run regularly over the direct current lines into Indianapolis. One feature of the new condition was the opening of the circuit with four motors in series, the motors having laminated fields which give greater field discharge than solid poles. The remedy was obviously the strengthening of the insulation. This brings out the interesting fact that operation on alternating current at 3,300 volts with an intervening transformer is less severe upon the motor than operation on direct current at 500 volts. Experience showed wherein the control apparatus, suitable for both alternating and direct current, could be simplified and the apparatus reduced in quantity. The result is a control system which is relatively simple and compact, although suitable for operation interchangeably between alternating current and direct current. The best verdict upon the working of the system has been given by the operating company. It is found in the contracts which have been placed for extending the present line a distance of 16 miles; also in extending the single-phase operation to the Shelbyville line, both to the 20 miles which have been operated by direct current and for a 20-mile extension. The length of track is therefore to be increased from about 40 to 100 miles; the number of cars will be double the present number and all equipments will be similar. It is significant that a company which has been operating two substantially similar suburban lines, one by single-phase current and the other by direct current, should see fit to throw out the direct current and substitute single-phase alternating current. It may be noted that this course was taken, although the reverse was easily possible, as provision was made in the original contract for the single-phase apparatus by which it would be exchanged for direct current equipments if its operation proved unsatisfactory.

Other single-phase roads which are operating Westinghouse equipments show a variety of conditions, some having exceptionally sharp curves and steep grades. On the road between Derry and Latrobe, in Pennsylvania, 30-ton cars are started on a 10% grade. The cars have platform controllers and are equipped with four 50-HP. motors. In some cases the initial operation has been handicapped on account of incompleteness, or through the use of temporary apparatus either in the power house or on the car. In its fundamental elements, however, the operation is proving perfectly satisfactory.

The extension to long distances will soon be shown in the carrying out of the contract which has been closed by the Spokane & Inland Railway Co. for 150 miles of railway running south from Spokane, Wash. The equipment will consist of 15 motor passenger cars each with four 100-HP. motors, 6 motor freight cars, each with four 150-HP. motors and six 40-ton freight locomotives. The engineer of this road has been intimately connected with the installation and operation of the single-phase road at Indianapolis.

The most notable recent event in electric traction is the purchase of Westinghouse single-phase locomotives by the New York, New Haven & Hartford Railway Co. The passenger trains on this road which enter Grand Central Station in New York run over the tracks of the New York Central Railroad for about 12 miles. As steam locomotives cannot enter the new terminal station and as the New York Central is equipping its track for direct current it is imperative that the New Haven trains be handled over 12 miles by direct current power. Instead of changing from electric to steam locomotives for all local and through trains at the end of 12 miles it was decided to extend the electrification and to do it, not by extending the direct current, but by changing to alternating current. The single-phase locomotives will be designed so that they may operate interchangeably from direct current or from single-phase alternating current.

The adoption of the single-phase system by one of the leading railroads of the country for its heavy and important passenger service is all the more noticeable, first, because its officials are already familiar with electric traction matters through the operation of many important city and interurban railways in New England, and second, because the obvious thing to have done would have been to follow the example of the New York Central by adopting direct current locomotives. Probably this is the turning point, and the coming electrification of heavy railways will follow the conspicuous example set by the New York, New Haven & Hartford Railroad Co. by adopting the single-phase system.

A paper on "Electric Railway Equipment" was presented by Mr. W. B. Potter (General Electric Co., Schenectady, N. Y.). In this paper the author recites some of the improvements that have been made in recent years in the motors and accessory equipment of standard direct-current electric cars.

AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION.—A paper on "Power Distribution" was read by Mr. C. H. Hile (Boston Elevated Ry. Co., Boston, Mass.), which described some features of the distribution network of the Boston elevated and surface car system, especially the interconnection of the several power stations. A similar subject was treated by Mr. L. P. Crecelius (United Railways Co., St. Louis, Mo.) in a paper entitled "The Power Station Load-Factor in Relation to Cost of Operation." In St. Louis, to improve the power factor of the main stations, two smaller stations, which are some distance away and are connected to the main stations by special connection cables, are operated on swing watches, to carry the peak loads only.

Under the charge of a committee on Controlling Apparatus, two papers on car control were presented. They were "Multiple Unit Systems of Train Control," by Mr. Hugh Hazelton (New York, N. Y.), which described multiple unit control in its general features and spoke for the use of multiple-unit type of apparatus on single cars also; and "The Series-Parallel Railway Controller," by Mr. W. A. Pearson (New York City Railway Co., New York, N. Y.), which outlined to concise form the development of the standard series-parallel control. The discussion on these papers was rather animated, and showed a general sentiment that there is great need for a type of control (for single cars) which will be entirely under the car floor, as is the multiple-unit apparatus, but will be simpler than the latter. Announcement was made of two forms of control which have been worked out to meet this requirement. One was devised by Mr. E. W. Olds (Milwaukee Electric Railway & Light Co.), with the cooperation of the General Electric Co.; it comprises an ordinary "Type K" controller (hand-operated) and two unit switches of the General Electric Co.'s "contactor" form, so arranged that the actual breaking and transfer of circuits takes place in the contactors only, thus removing the possibility of "fireworks" from the front platform. The other was developed by Messrs. R. C. Taylor and E. Taylor (Brooklyn Rapid Transit Co., New York, N. Y.), and consists of an ordinary cylinder controller, under the car floor, which is rotated by an electromagnet adapted to notch the controller around a step at a time. In this device a current-limiting stop is inserted, so that the automatic action of the controller can proceed only fast enough to give a smooth, limited acceleration. The release in all the motions of this control system is by spring power or by gravity, without relying on electric circuits. Further, a brake valve is under control of the electric supply circuit. Thus, if the trolley-pole comes off, the controller goes back to open circuit and the brakes go on simultaneously.

An important fact brought out in the discussion of controllers was that the increased trouble in late years from controller burnouts is due not alone to the greater weight and power of cars, but also to the better distribution systems, which are able to keep up the trolley voltage in spite of an incipient short-circuit arc, and thereby can hold up a strong burn-out in the controller.

Another set of papers which resulted from the work of a special committee dealt with Rail Joints. The several papers were: "Bolted Rail Joints," by the committee chairman, Mr. F. G. Simmons (Milwaukee Electric Railway & Light Co., Milwaukee, Wis.), which discussed the advantages of the Weber and the Continuous rail joints; "Thermit Rail Welding," by Mr. G. E. Pellissier (Holyoke Street Railway Co., Holyoke, Mass.); "Joints and Track Construction in Philadelphia," by Messrs. H. B. Nichols and C. B. Voynow (Philadelphia Rapid Transit Co., Philadelphia, Pa.); "Electric Rail Welding," by Mr. T. W. Wilson (Buffalo, N. Y.); and "The Cast Welding of Rail Joints," by Chairman Simmons. These papers produced the most lively discussion of any before this society, but there was little new information in the remarks of the speakers except that all the forms of joint described have given good results where properly used. The joints are probably all familiar to engineers except the Philadelphia "zinc" joint and the system of track construction used with it. These represent novelty and very thorough design. A section of 9-in. track showing the progress of construction under this system was on view in the exhibition at the convention.

Two further papers before this society were: "The Power House," by Mr. F. N. Bushnell (The Rhode Island Co., Providence, R. I.), and "The Track Brake," by Mr. F. F. Bodler (United Railroads of San Francisco, San Francisco, Cal.). The latter paper was reprinted in our last week's issue (Sept. 28, 1905).

STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA.—The committee reports and papers included the following: Committee on Classification of Accounts, Mr. C. N. Duffy (Chicago City Railway Co., Chicago, Ill.); Committee on International Form of Report, Mr. C. N. Duffy; Committee on Standard Form of Report, Mr. W. F. Ham (Washington Railway Co., Washington, D. C.); "The Cost of Carrying a Passenger," Mr. C. S. Tingley (American Railways Co., Philadelphia, Pa.); "Interurban Fare Collections," Mr. Irwin Fuller (Detroit United Railway, Detroit, Mich.); "Interurban Ticket Accounting," Mr. J. H. Pardee (Rochester & Eastern Rapid Ry., Canandaigua, N. Y.); "Accounting with Four Departments," Mr. H. M. Beardsley (Elmira Water, Light & Railway Co., Elmira, N. Y.).

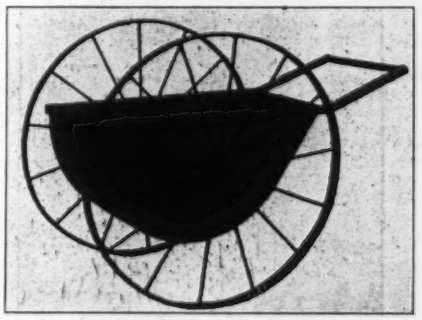
The several associations elected the following officers for the coming year:

American Street & Interurban Railway Association.—President, W. C. Ely, of Buffalo, N. Y.; Vice-Presidents, J. I. Beggs, of Milwaukee, Wis., C. G. Goodrich, of Minneapolis, Minn., and J. F. Shaw, of Boston, Mass.

American Railway Mechanical and Electrical Association.—President, H. H. Adams, of Baltimore, Md.; Vice-President, F. G. Simmons, of Milwaukee, Wis., J. S. Doyle, of New York, N. Y., and Paul Winsor, of Boston, Mass.; Secretary and Treasurer, S. W. Mower, of Detroit, Mich.

A PUSH CART FOR TRANSPORTING CONCRETE.

The accompanying cut shows a push cart designed to be used in place of a wheelbarrow for transporting concrete. As will be seen, the cart is built entirely of steel with large wheels and small axles. With the handle attached, as shown in the illustration, the body of the cart can be turned upside down for depositing concrete in floors, pavement foundations. For filling wall or girder forms, the cart is arranged so that the nose of the body will strike the run-plank or



A Push Cart for Transporting Concrete.

the edge of the form, by simply transferring the handle to the position opposite that shown in the engraving.

The builders claim that while these carts can be used with great advantage in transporting concrete mixed with shovels, they are particularly useful where concrete mixers are employed, for with a comparatively level runway of plank, it is possible for one laborer to convey the equivalent of three large wheelbarrow loads, and with no greater effort than is required to push a wheelbarrow. Moreover, no concrete is spilled over the sides of the bowl, so that the runway

does not become covered with materials that increase the rolling friction. This is a point that is more important than commonly realized by contractors and builders. A very slight amount of dirt upon a run-plank will easily double the force required to push a cart or wheelbarrow over it, and where the plank is covered with sloppings from wheelbarrows the resistance is correspondingly greater. In loading the cart from concrete mixers very little time of the mixer is lost, in fact it takes no longer to load the 6 cu. ft. of concrete into one of these carts than is required to load the 1 cu. ft. into the wheelbarrow, from which it is obvious that the daily output of the mixers can be greatly increased where carts are used. As confirming this statement, it may be said that where contractors have replaced wheelbarrows with carts there has been no reversion to the use of barrows. Among those who are using large numbers of these carts may be mentioned: The Expanded Metal Fireproofing Co. of Pittsburg, Pa.; Frank D. Gilbreth, of New York, and the National Fireproofing Co. of Pittsburg, Pa. These carts are made by the Ransome Concrete Machinery Co., of 11 Broadway, New York city.

A CONDENSER FOR SHAFT-SINKING PUMPS AND MINE PUMPS.

We illustrate herewith a very compact ejector condenser attached to a shaft-sinking pump. The great advantage of the condenser in this place is not the increased power and greater economy due to condensation, although these are important, but the fact that the exhaust steam is disposed of without the trouble and expense of a separate exhaust pipe line, which must be broken and extended every time the pump is lowered.

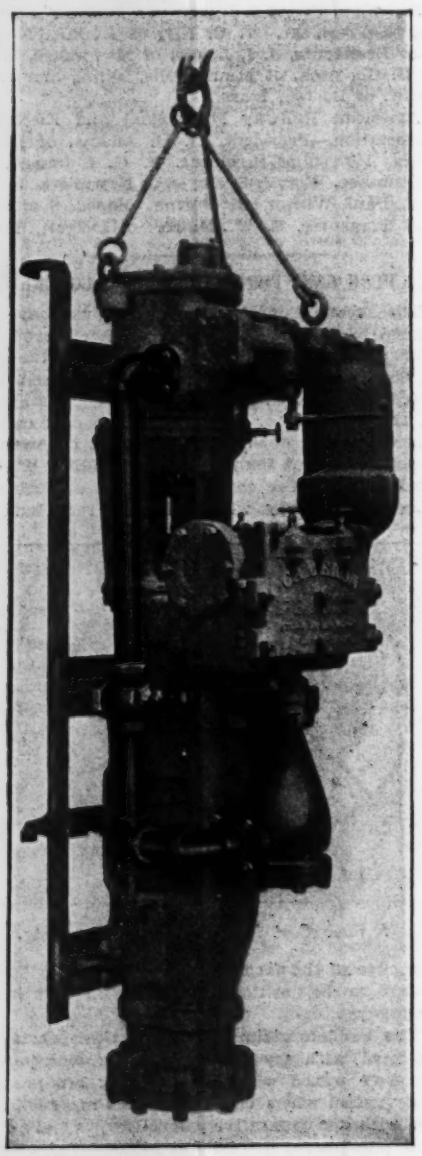


Fig. 1. Perspective View of Cameron Shaft Sinking Pump, with Condenser Attached.
(Exhaust Pipe and Condenser are Shaded Dark.)

Of course to make the use of a condenser feasible on a shaft-sinking pump, it has to be reduced to very small proportions. In the accompanying illustrations Fig. 1 shows a perspective view of the pump, with the condenser and exhaust-pipe distinguished by darker shading. The condenser is bolted directly to the bottom of the water-valve chest. Fig. 2 is a sectional view through the exhaust inlet. It will be understood, of course that the steam is condensed by contact with the cool suction water passing to the pump. In starting up this pump, the exhaust is opened to the atmosphere for one or two strokes until the water cylinder is filled, and then the three-way valve is turned, closing the exhaust steam outlet and directing the steam to the condenser.

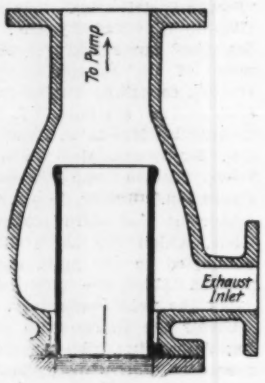


Fig. 2. Section Through Exhaust Inlet of Condenser.

The apparatus is manufactured by the A. S. Cameron Steam Pump Works, E. 23d St., New York City, and we are indebted to that firm for the information concerning the condenser and for the cuts here reproduced.

A WOODEN TRACK BRAKE SHOE USED ON SAN FRANCISCO STREET RAILWAY CARS.

In the article, printed in our last issue, "An Emergency Track Brake for Street Railways," by F. F. Bodler, describing a slipper brake used on the cars of the United Railroads of San Francisco in San Francisco, Cal., the drawing of the wooden brake shoe was accidentally omitted. The cut is shown herewith. The shoe is of Oregon Pine, and

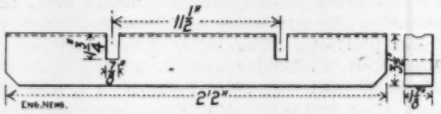


Fig. 2. Oregon Pine Shoe for San Francisco Track Brake.

lasts about one week; its cost is about 2¾ cts. After considerable experimenting with wooden, metal, and insert shoes, the shoe of Oregon Pine was found to be the best, considering both cheapness and braking power. The cut here shown is referred to as Fig. 2 in the article noted above (Eng. News, Sept. 28, 1905, p. 327).

NOTES FROM THE ENGINEERING SCHOOLS.

UNIVERSITY OF ILLINOIS.—The installation of President James will take place with appropriate ceremonies on Oct. 18 and 19.

UNIVERSITY OF MICHIGAN.—There has been bought for installation in the hydraulic laboratory of the new Engineering Building the Doble tangential water wheel which won the grand prize at the St. Louis Exposition. The wheel will be mounted in connection with a duplex pump for experimental purposes, its output being 100 HP. when operating under a head of 580 ft. We are informed that 12-in. Doble laboratory water motors have been ordered recently by the University of Wisconsin, the Michigan School of Mines and the University of Toronto.

UNIVERSITY OF CHICAGO.—One of the marked differences between the universities of today and the past is the constant effort of modern institutions to meet the wants of all classes instead of a favored few. Engineering and various other technical courses have been followed by departments of commerce. Specialization in industrial education will doubtless be a feature of future university work, as it long has been in various isolated trade schools.

At the University of Chicago there will begin on Oct. 3 a special four-year course in railway education. The course being designed for railway employees, the lectures will be held in the evening. A large registration for the course already reported.

An advisory board on railway education, composed mostly of railway men, has been established, with E. W. McKenna, Assistant to President Earling of the Chicago, Milwaukee & St. Paul Ry., as Chairman, and Daniel Willard, second vice-president of the Chicago, Burlington & Quincy Ry., as Vice-Chairman. Among those who form this board are: A. C. Bird, A. F. Burgess, W. C. Brown, F. A. Delano, J. T. Harahan, N. Faithorn, S. M. Felton, W. A. Gardner, S. T. Fulton, J. Kruttschnitt, and B. Thomas. They will plan the courses which are to be given, and will themselves as occasion requires deliver lectures.

The first year's course, from October to June, will be devoted to railway conditions in the United States. The second year will be devoted to freight service, railway transportation, railway law, and rate regulation. During the third year the following branches will be covered: Passenger service, statistics and geography of railways, signaling and train service, railway auditing and finance, and terminals. During the fourth year the following subjects will be studied: Motive power, car equipment, track, railway development abroad, and railway economics.

ENGINEERING MATERIAL PRICES.

TRACK FASTENINGS—
Pittsburg f. o. b. cars—Angle bars, 1.50 cts.; spikes, 1.70 to 1.75 cts.; bolts, square nuts, 2.15 cts.; bolts, hexagonal nuts, 2.40 cts.

RAILS, STEEL—
New York—at mill—New standard sections, $28; standard, second quality, $27; light sections, 12 to 25 lbs., $24 to $26; old iron, f. o. b. New York, $21 to $22; old steel, long lengths, $14.75 to $15.75; old steel, short pieces, $14.50 to $15; relayers $23 to $24.
Pittsburg—Standard sections, at mill, $28; standard, second quality, $27; light rails, 12 to 25 lbs., $24 to $26.

STRUCTURAL MATERIALS—
New York—at tidewater—Beams and channels, up to 15-in., 1.84½ cts.; over 15-in., 1.84½ cts.; angles, 3 × 2 and up to 6 × 6, 1.84½ cts.; zees and tees, 1.89½ cts.; steel bars, half extras, 1.74½ cts.

PLATES AND SHEETS—
New York—at tidewater—Sheared plates, tank, 1.74½ to 1.84½ cts.; flange, 1.84½ to 1.94½ cts.; marine, 1.94½ to 2.04½ cts.; still bottoms, 2.04½ cts.; fire box, 2.24½ to 3.05 cts.
Pittsburg—Tank, ¼-in., thick and heavier, 1.60 cts.; black sheets, 27 gage, 2.25 cts.; black sheets, 28 gage, 2.30 cts.

IRON—
Pig Iron:
New York—tidewater—No. 1 X Foundry, Northern, $17.25 to $17.50; No. 2 X Foundry, Northern, $16.75 to $17.25; No. 2, Plain Foundry, $16.25 to $16.75; Gray Forge, Northern, $15 to $15.50; Basic, Northern, $15.75 to $16; Basic, Virginia, $16; No. 1, Virginia Foundry, $17.15 to $17.65; No. 2 Virginia Foundry, $16.65 to $17.15; No. 1 Foundry, Southern, $16.25; No. 2 Foundry, Southern, $15.75 to $16; No. 3 Foundry, Southern, $15.25; No. 4 Foundry, Southern, $14.75; No. 1 Soft, Southern, $14.75; No. 2 Soft, Southern, $15.75; Gray Forge, $14 to $14.25; Mottled, $14 to $14.25.
Pittsburg—f. o. b. cars—No. 2 Foundry, $15.60 to $15.75; Gray Forge, $14.50; Bessemer Iron, $15.85 to $16.35; Ferro Manganese, $51; Muck Bars, $27.35 to $28; Iron Bars, $1.70.
Cast-Iron Pipe:
New York—Carload lots, net tons, 6-in., at tidewater, $27.50.
Chicago—4-in. water pipe, $29.50; 6-in. and larger, $28.50, with $1 extra for gas pipe.

MISCELLANEOUS MATERIALS—
Asphaltum:
Ventura and other California asphalts, $20 to $21 per ton at New York; Trinidad refined, $25 to $30 per ton; Venezuela asphalt, $25 to $30 per ton; Bermuda asphalt, $25 to $30.
Cement:
Rosendale, 85 cts.; Portland domestic, in sacks, $1.15 to $1.20; in wood, $1.45; German Portland, $1.90 to $2.10.
Copper:
Lake, 16.25 to 16.50 cts.; electrolytic, 16.25 to 16.50 cts.; casting, 16 to 16.25 cts.
Lead:
New York, spot, 4.85 to 4.90 cts.
Spelter:
New York, spot, 5.95 to 6.05 cts.
Tin:
New York, spot, 32 to 32.50 cts.
Tar:
New York, $6 per bbl.
Pitch:
New York, $2.95 per bbl.

LUMBER—
New York, wholesale prices:
Hilling—Spruce, ordinary cargoes, 6 to 7 cts.; oak, 14-in. butt, 40 to 50 ft., 19 cts.; 50 to 55 ft., 22 cts.; 55 to 60 ft., 23 cts.; 60 ft. and up, 25 cts.; pine, 60 to 65 ft., $8.50; 70 to 75 ft., $10.50; 80 ft. and up, $16.
Railroad ties—Yellow pine, 6 × 9 ins. × 8 ft., 63 to 65 cts.; 6 × 8 ins. × 8 ft., 58 to 60 cts.; 7 × 9 ins. × 8 ft., 70 to 72 cts.; 7 × 8 ins. × 8½ ft., 66 to 68 cts.; 7 × 9 ins. × 8½ ft., 71 to 73 cts.

THE SOUTH TUNNEL of the Hudson River Tunnel—Jersey City to New York—was officially opened by the officers of the New York & New Jersey R. R. Co. on Sept. 30. The breaking down of a brick bulkhead, erected in August, 1882, by one of the former companies, completed communications with New York on this south tunnel, though the driving of the approaches and the opening of the two tunnels to traffic will require about a year longer. The north tunnel was completed on March 14, 1904, and is now lined with concrete and ready for track laying. This south tunnel was started at the Jersey City end in November, 1874; work was then suspended for a time, and again resumed in September, 1879, and 500 lin. ft. of tunnel were built up to April 22, 1882, including about 30 ft. of tunnel driven at West and Morton Streets on the New York side. After the failure of various attempts to promote this enterprise, and some work done in 1891, the present company took hold of it, completed the north tunnel as stated, and in 1903 it commenced operations on the south tunnel. The tunnel originally built was 18 ft. high by 16 ft. wide, formed of comparatively thin poling plates lined with brickwork about 24 ins. thick. As fully described and illustrated in Engineering News of Nov. 10, 1904, the engineers, Messrs. Jacobs and Davies, devised a powerful hydraulic plant and shield for the driving of the new tunnel, with the view of obtaining high speed in construction. The diameter of this shield is 17 ft., with an outside tunnel diameter of 16 ft. 7 ins. The whole new tunnel is built of extremely heavy segments of cast iron, machined on the four faces of each segment, and the joints are extremely tight even under the pressure of 65 ft. of water over the tunnel, and with only 15 ft. of mud—in some cases over the crown of the tunnel. As showing the rapid rate of progress, it may be said that this south tunnel was built on a basis of continuous day and night work, in 334 actual working days, the shield being forced through the greater part of the distance without any advance excavation. The record 24-hours work was 62 ft. of tunnel finished; and in one week 348 ft. of tunnel was driven. The total length of this tunnel is 5,700 ft. between the centers of the shafts on the New Jersey and New York sides; and about 5,100 ft. of this have been built by the present company. The average air-pressure was 30 lbs. to the square inch; and in the course of this difficult and dangerous work not one life has been lost as a result of working in compressed air. This record is largely due to the very complete "hospital lock" installed at the New Jersey shaft, and to the arrangements made for the safety and health of the working force. An unusual condition in tunnel-driving of this type was the presence of rock in the bottom of the tunnel on the New York side of the channel. For a distance of about 600 ft. this rock projected from four to five feet into the tunnel section, and about 7,000 light charges of dynamite were fired in its removal without damage to the shield.

THE LABOR SITUATION AT PANAMA has been greatly misrepresented by the newspaper reports concerning the enforced landing of negro immigrants from Martinique on Sept. 30. It has been stated that the immigrants were compelled by force to go to the canal works. The actual fact is that the whole matter grew out of the refusal of the immigrants to submit to vaccination on their arrival, as required by the health authorities. A cable dispatch from Gov. Magoon gives the following particulars:

The steamer arrived in Colon Harbor on Saturday, Sept. 30, with 375 passengers from Martinique and 300 Colombians, negro laborers, destined for work on the canal. The Panama health regulations require all immigrants to be vaccinated. When the Martinique immigrants learned this they refused to land and remained on the vessel declaring that they must be given their return passage to Martinique. They had no objection whatever to make about the amount of work they had to perform, and made no assertions that they had in any manner been deceived as to the character of the work. What they objected to was vaccination and their opposition to that was due to the influence of a Voodoo doctor among them. The agent of the steamship line appealed to the French consul for assistance in overcoming their fears and he was successful in persuading 75 of them to be vaccinated. The others still held out and the consul then requested the Panama police to assist the ship's officers in removing the immigrants from the vessel. It is customary for the Zone police, stationed at Cristobal to assist Colon police in handling crowds of passengers coming from the dock to the railroad station. The sergeant and eight policemen went to the dock. When the men still remaining on the steamship saw them they came off the vessel with a rush seeking to avoid vaccination by going away. In checking this rush, the Panama and Zone police used their clubs, but not brutally, and no one was seriously injured. All of the men were vaccinated finally and taken to Corozal.

The authorities at Panama regard preservation of health as of the first importance and insist that the health regulations shall be strictly enforced. The quarantine regulations are all under the charge of officers of the United States Marine Hospital service, and it was under their direction that the proceedings on Saturday were carried forward.

THE NEW YORK ELEVATED RAILWAY WRECK of Sept. 11, 1905, in which 12 persons were killed (Eng. News, Sept. 14, 1905, p. 281), has been the subject of a coroner's inquest and of an investigation by the New York State Board of Railroad Commissioners. The latter, which was taken up within a few days after the accident, resulted in the recommendations: (1) That a two-blade semaphore be installed at the 53d St. junction where the accident occurred, one blade to govern absolutely the south-bound Ninth Ave. trains, the other the south-bound Sixth Ave. trains; and (2) that all south-bound) trains be required to come to a full stop just before the switch. Hitherto trains had been permitted to run through the (facing) switch at speeds of 8 miles per hour for Sixth Ave. trains (which take the turnout) and speeds of 15 to 25 miles per hour for Ninth Ave. trains (which take the main track through the switch). The coroner's inquest resulted in a finding that the motorman of the wrecked train and the towerman in charge of the switch and signal tower at the crossing are blameable for the wreck. The towerman set the switch for Sixth Ave., although the approaching train was plainly marked Ninth Ave. in the regular manner; the motorman failed to observe the Sixth Ave. switch signal and ran into the switch at a speed probably exceeding 15 miles per hour. The towerman is in custody. The motorman, who disappeared immediately after the accident, has not yet been apprehended.

THE GAYNOR-GREENE CASE has arrived at the end of Chapter II.: The Struggle Against Extradition. The last recourse of delay, a habeas corpus petition to Justice Ouimet (Montreal) against the commitment of Magistrate Lafontaine for surrender, failed by denial of the petition on the grounds that the commitment is regular and that extraditable offences (participation in fraud by agent, embezzlement, and receiving stolen money) are disclosed. This habeas corpus petition was the second after the action of the Imperial Privy Council in London in reversing the action of the Quebec authorities who set the defendants at liberty. The press reports state that the accused, B. D. Greene and J. F. Gaynor, now declare themselves ready to return to the United States, feeling certain that they can now secure a fair trial. The Canadian Minister of Justice signed the extradition warrant on Oct. 2, 1905, and the men will be in the United States within a few days.

A NEW TRANSATLANTIC CABLE is being laid by the Commercial Cable Co. The cable steamer "Colonia" is now engaged in the work, proceeding from Canso, N. S., toward the coast of Ireland, where a short length had been laid some time ago.

THE WESTERN PACIFIC RY., which is the proposed new line from Salt Lake City, Utah, to San Francisco, is discussed by Mr. E. T. Jeffery, President of the Denver & Rio Grande Ry., in his annual report. The first contracts for the construction of this line have already been awarded, and Mr. Jeffery expects that it will be completed within three years. The line is intended to give the Denver & Rio Grande Ry. (and the Gould system generally) a route to the Pacific coast independent of lines controlled by the Southern Pacific Ry., partly on account of traffic restrictions imposed by the latter and partly on account of the probable development of commerce with the Philippine Islands, Japan and China. The following is an extract from Mr. Jeffery's report to the Denver & Rio Grande Ry. Co.:

These considerations led the management to investigate the feasibility of an independent line, and to resist in promoting the plans of the Western Pacific Ry. Co., a corporation organized under the laws of California for the purpose of building a railway from San Francisco to Salt Lake City, with certain proposed branches. Careful investigations and preliminary surveys were made, under the auspices of your company, some of them by its Chief Engineer, Mr. E. J. Yard, and his assistants, for the purpose of determining the best available route. These were supplemented by the professional services of Mr. Virgil G. Bogue, an engineer of experience, acting under the general direction of your company. These engineering efforts were successful beyond expectation and a main line has been definitely located, which, through the Sierra Nevada range of mountains, has a maximum gradient of 1% in each direction, and lighter grades on both sides of the range, with satisfactory alinement throughout, and which, in general desirability and advantages, affords a route superior to any existing line to the California coast. The management of the Western Pacific Ry. Co. placed all plans, surveys and information at the disposal of your officers, and, after protracted negotiations, the control of that corporation was transferred to your company with all rights, franchises and property interests, including about 38 miles of railway in operation. As planned, the main line between San Francisco and Salt Lake City will be substantially constructed, according to modern specifications, and will be laid with steel rails 85 lbs. per yd. It will connect at Salt Lake City with the Rio Grande Western Ry. The authorized capital stock of the Western Pacific Ry. Co. is $50,000,000, which will be increased to $75,000,000.

THE CANADA ATLANTIC RY. SYSTEM has been purchased by the Grand Trunk Ry. Co. and is to be operated as the Ottawa Division of the Grand Trunk system. The Canada Atlantic system extends from a terminus at Parry Sound on Georgian Bay eastward to Ottawa and thence to a junction with the Centra. Vermont lines of the Grand Trunk system near the International Boundary. By these lines access is obtained to Long Island Sound and to Montreal. The total extent of the lines taken over is 460 miles.

THE CHOLERA IN GERMANY had resulted in 246 reported cases and 85 deaths up to noon of Sept. 25.

A FLOATING INDUSTRIAL EXPOSITION for displaying important products of American manufacturers to foreign customers is projected by the Export Shipping Co., of 11 Broadway, New York City. It is proposed to charter an 8,000-ton transatlantic steamer and devote the entire space on three decks to exhibits of American manufactured goods. The vessel will make a 15 months' voyage and will visit all the principal commercial points of Europe, Asia, Australia and South America. The charge to exhibitors will be at the rate of $5 per sq. ft. for exhibition space used, and the minimum space allowed each exhibitor will be 40 sq. ft. In addition each exhibitor can have a representative who will make the trip on board the steamer at an expense estimated at $500 for the 15 months' trip. The vessel will have sufficient passenger capacity to accommodate about 200 traveling representatives.

A NEW METHOD FOR CLEANING STONEWORK has just been given a practical trial by the Treasury Department. The whole of the Treasury Building has been cleaned for the first time in 40 years. The work was done in fifty days and the change in the appearance of the building from a sooty gray to granite white is as striking as if it had been rebuilt of new stone. The cleaning has been done by the aid of a liquid preparation invented by Mr. James F. Bruce, of Washington, D. C. The ingredients of the liquid are secret, but the inventor has applied for a patent. The liquid is colorless and does not in any way injure the stone. It is applied with an ordinary paint brush and this is followed by a wet sponge which seems to gather up the cleansing liquid and the dirt. The work is finished by the application of a hose and the granite appears as clean as if new. The result is said to be as satisfactory as the sand-blast method for granite and other hard stone, though inapplicable to sandstone. It is also much less disagreeable to owners of neighboring property and to passers-by. The chief advantage of the process lies, however, in its extreme cheapness and in the ease and rapidity with which it is applied. The entire cost of cleaning the Treasury Building, covering a square of ground, was only $2,000, as against a possible $10,000 by the sand-blast method.

AN INDUSTRIAL EXPOSITION of small motors, pumps, presses and machinery suitable for small industries is to be held under direction of the Chilean Government at Santiago, Chile, beginning in April, 1906, and continuing for two months. No charge is to be made for exhibition space and the exposition authorities offer to pay the freight charges from New York and return thereto on exhibits sent from the United States. A steamer will sail from New York on Oct. 20 controlled by Beeche, Duval & Co., 25 Broad St., on which exhibits may be sent. Intending exhibitors should communicate immediately with Mr. W. Sierra, C. E., the Chilean Exposition delegate in the United States, P. O. Box 207, Dayton, O., who will furnish printed matter giving the necessary detailed information.

A UNIQUE BID FOR SEWER CONSTRUCTION was recently received by the City Council of Douglas, Alaska. According to the Douglas "News" it read verbatim as follows:

The cost of metiril we no. There is stumps in the way we no. And there is bolders in the way we don't no. There is quick sand that will run we no. There is hard pan that is hard I no. Anyone that will take it fer less than 35 cts a foot will go in the hole I no.

A SERIES SINGLE-PHASE ELECTRIC RAILWAY between Atlanta and Marietta, Georgia, the first alternating-current railway in the Southern States, was put into service a short time ago. The line is about 15 miles long and runs on private right-of-way, parallel to the Western & Atlantic R. R. (of the Nashville, Chattanooga & St. Louis Ry.). Its location is better than that of many interurban lines, the maximum grade being 3% and the sharpest curve about 10° (574 ft. radius). The gage is standard, 4 ft. 8½ ins. The roadbed is ballasted with blast-furnace slag, and the track is laid with 70-lb Tee rails. The major part of the line has a 000 trolley wire with cross suspension, which forms the entire low-potential distributing system. The trolley current is 2,200 volt, 25 cycle. Power is supplied by the Atlanta Water & Electric Power Co.'s hydraulic station, 18 miles from Atlanta, and is transmitted at 22,000 volts. Reserve supply may be obtained from a steam-operated station belonging to the Georgia Railway & Electric Co., owning the Atlanta street railway lines. The transmission is three phase; each leg of the line feeds one-third of the trolley line. Two transformer substations are provided for each section, the substations being located a little over three miles apart. Each substation is equipped with a single 150-KW. oil-insulated self-cooling transformer. The substation in the city of Atlanta gives a secondary tension of 550 volts, alternating, and in order that the equipment may be interchangeable all transformers have taps to give either 2,200 or 550 volts. The line is owned and operated by the Atlanta Northern Railway Co. Six passenger cars and one freight car are provided. Each car has two trucks and is fitted with four 50-HP. mo-

tors (No. 108) of the Westinghouse Electric & Mfg. Co. The passenger cars have auto-transformer control, with five taps to the motors, and two taps for the trolley circuit to accommodate the supply voltages of 2,200 and 550. A double-throw oil switch makes the change from one supply voltage to the other. The motor connections are made by a drum controller on each platform. The freight car is designed so that it may also be run over the direct-current city lines, and accordingly is equipped with a combination transformer and rheostatic control. The cars have wheel trolleys, the pole being mounted on porcelain insulators on account of the high line voltage. Each car has two trolley poles. Straight air brake equipments are fitted, the compressor being driven by a motor similar to the main motors. Mr. A. Balsey is Chief Engineer and Mr. Wm. Glenn is Engineer of Maintenance-of-Way of the Atlanta Northern Ry. Co.

FIRE TESTS OF WIRE GLASS windows and skylights were recently made at the plant of the British Fire Prevention Committee. In the window test five squares of wire glass 2 ft. 3 ins. x 4 ft. 6 ins. were set in a brick wall, one in a brick frame, two in steel frames, and three in brick reveals. The fire endured for 45 mins., with temperatures ranging from 650° F. to 1,450° F.; immediately on lighting the gas the glass in all the openings cracked, particularly around the edges, and beyond the cracks increasing no particular change occurred during the firing. The fire did not pass through the glass. On application of water through a ¾-in. nozzle under 45 lbs. per sq. in. pressure an irregular patch of small holes was made in the upper portion of the center window which was also bulged inward; otherwise the glass in all the windows remained in position. In the skylight tests four squares of glass about 2 x 2 ft. were placed in the roof of the test house so as to set horizontally. The fire endured 45 mins. and reached a temperature of 1,650° F. Immediately on lighting the gas the glass in all four squares cracked in various directions, beyond this no perceptible change occurred during the fire test. Water was applied to the underside of the glass through hose and also poured on the tops of the glass; its effect was to develop hair cracks all over the glass, but no water passed through. Glass ¼-in. thick made by Pilkington Bros., Ltd., of London, was used in all the tests.

GRADE REDUCTION on a short but difficult piece of line has been completed by the Nashville, Chattanooga & St. Louis Ry., on its Nashville division. The reduction extends over a distance of 4,000 ft., and the track has been lowered 29 ft. at the deepest place, making the new cut 74 ft. deep. The work involved the excavation of 33,000 cu. yds. of solid rock and 138,000 cu. yds. of earth and loose rock, the waste material being used in widening embankments, filling trestles and grading new side tracks. The maximum grade was reduced from 172 ft. to 72½ ft. per mile (3.26% to 1.37%), and freight trains now ascend without doubling, while passenger trains with extra cars no longer require two engines. The work occupied about two years and cost $60,826. It was done under the direction of Mr. Hunter McDonald, M. Am. Soc. C. E., Chief Engineer.

A DEVICE FOR CLEANING SMALL PIPE of rust and oil preparatory to painting was described before a recent meeting of the Pacific Coast Gas Association by Mr. H. Weber. A wooden drum, 4 ft. in diameter and 22 ft. long, is employed. A number of lengths of the pipe to be cleaned are placed in the drum, together with enough sharp sand to cover the pipe. The drum is then revolved at about 10 revs. per min. By this means Mr. Weber stated that he had thoroughly cleaned about eight miles of 2-in. steel tubing that was in bad condition, supplying the pipe as rapidly as four men could paint it.

IRRIGATION PUMPING PLANTS are proposed in connection with the Williston, Nesson and Buford irrigation projects in North Dakota, and it is expected that work on the three projects will be commenced next spring under the direction of the U. S. Reclamation Service. On the Buford project, water will be pumped from the Missouri River to irrigate a narrow plain parallel with but at some height above the river. The three projects provide for the irrigation of 39,000, 28,600 and 18,700 acres, respectively.

PERSONALS.

Mr. W. L. Darling, M. Am. Soc. C. E., has resigned his position as Chief Engineer of the Chicago, Rock Island & Pacific Ry.

Mr. Wm. C. Curd has been appointed Engineer Maintenance of Way of the Macon, Dublin & Savannah R. R., with headquarters at Macon, Ga.

Mr. E. Tappan Tannatt, of Spokane, Wash., has been appointed Professor of Civil Engineering at Montana State Agricultural College, Bozeman, Mont.

Mr. E. Clarence Hingston, formerly in the employ of the Marion Steam Shovel Co., of Marion, O., has accepted a position in the Dredge Department of the Allis-Chalmers Co., of Milwaukee, Wis.

Mr. George L. Warner, Assistant Engineer in the U. S. Reclamation Service, has been transferred from Oklahoma work and assigned to duty with Mr. B. M. Hall, at Carlsbad, N. Mex.

Mr. O. A. Stranahan, who joined the Allis-Chalmers Co. on Dec. 1, 1904, to become Manager of the Power Department, has been promoted to the position of Sales Manager. His headquarters are at Milwaukee.

Mr. Francis E. Blake, a mechanical engineer of Delmar, N. Y., and Miss Ethel A. Rockwood were married Sept. 27 at North Adams, Mass. The groom is a son of Mr. H. E. Blake, City Engineer of North Adams.

Mr. M. C. Miller, who joined the Allis-Chalmers Co. a little more than a year ago, has been made Assistant to the Sales Manager. He was formerly connected with the Westinghouse Electric Mfg. Co., at Pittsburg.

Mr. C. De Vere Fairchild, for the past two years in the Engineering Department of the Grand Trunk Pacific Ry., and Miss Edith Olive King were married Sept. 5 at Tacoma, Wash. They will reside at Fort William, Ont.

Mrs. Mary S. Holladay, of Greenville, Mo., until recently the only woman president of a railway company in the United States, has sold her interest in the Williamsville, Greenville & St. Louis Ry., of which road she was the president, and has retired from that position.

Mr. Artaur C. Jewett, formerly Instructor in Mechanical Engineering at the University of Maine, has been promoted to the grade of Associate Professor, in charge of the department of Mechanical Engineering. Mr. Thomas McC. Gunn, formerly Chief Draftsman of the Quincy Quarries Co., succeeds Mr. Jewett as Instructor.

Mr. Albert C. Lee, an electrical engineer of Providence, R. I., and his cousin, Mr. Y. C. Lee, a civil engineer of New York City, both natives of China, have been summoned to Canton by the viceroy ruling that province to make the preliminary estimates for the installation of a large municipal power and lighting plant.

Mr. A. T. Tomlinson, M. Am. Soc. C. E., has been transferred from the New York office of J. G. White & Co. to the Montreal offices of the Canadian White Co. Mr. Tomlinson is a graduate of the Royal Military College of Canada, and entered the employ of J. G. White & Co. in 1902. Previous to that he was in the employ of the Boston Elevated Ry. as Consulting Engineer.

Mr. R. F. Hayward, Assoc. Am. Inst. E. E., formerly Chief Engineer Utah Light & Railway Co., of Salt Lake City, has gone to the City of Mexico to assume the management of the Mexican Light & Power Co., Ltd. Mr. Frederick D. Nims, formerly Assistant Engineer of the Utah Light & Railway Co., has been appointed Chief Engineer of the company of which Mr. Hayward is the Manager.

Mr. W. T. McCaskey, who was until recently Manager for Agar-Cross & Co., of London, and for years before identified with Edison, Westinghouse and other electrical interests, has joined the Allis-Chalmers Co. and will act as a special representative where contracts are being considered for such work as the equipping of interurban railroads, hydro-electric projects and others requiring special knowledge. His headquarters will be in Milwaukee.

Mr. Geo. H. Follows has resigned his position in the Engineering Department of the Westinghouse Electric & Manufacturing Co., Pittsburg, Pa., and about Oct. 15 will take charge of Mechanical Drawing at the new Carnegie Technical Schools, Pittsburg, of which Mr. Arthur A. Hamerschlag is Director. Mr. Follows is preparing "A Universal Dictionary of Mechanical Drawing," a number of installments of which have already been published in Engineering News.

Mr. Kenneth B. Thornton, Assoc. Am. Inst. E. E., has been appointed Operating Engineer of the Canadian White Co., of Montreal. After taking a three years' course in electrical and mechanical engineering at the Central Technical College, South Kensington, London, England, Mr. Thornton returned to Montreal and entered the employ of the Royal Electric Co., in the manufacturing, testing and drafting departments. In 1895 he was transferred to the Operating Department of that company, which was supplying light and power in and around Montreal, and from that time until August, 1905, he was intimately associated with the construction, operation and engineering details in connection with the generation and distribution of light and power for the Royal Light Co. and the Montreal Light, Heat & Power Co. Mr. Thornton is a past President of the Canadian Electrical Association, and is an Associate Member of the Canadian Society of Civil Engineers.

Mr. August Ziesing, M. Am. Soc. C. E., President of the American Bridge Co., has made the following announcements:

Mr. Emil Gerber, in addition to his duties as assistant to the president, will assuume the duties of Operating Manager of the Pittsburg Division, covering the following plants: Ambridge, Canton, Chiffler and Toledo, with office in the Frick Building, Pittsburg, Pa.

Mr. E. A. Smith will assume the duties of Operating Manager of the Western Division, covering the following plants: American, Detroit, Lafayette, Lassig, Milwaukee and Minneapolis, with offices in the Monadnock Block, Chicago, Ill.

Mr. R. J. Davis will assume the duties of Operating Manager of the Eastern Division, covering the following plants: Athens, Berlin, Edgemoor, Pencoyd and Trenton, with offices at 15th and Chestnut Sts., Philadelphia, Pa. In addition, Mr. Davis has been reappointed Operating Manager of the Elmira and Brooklyn plants of the Empire Bridge Co.

Mr. Frank H. Alfred, M. Am. Soc. C. E., whose resignation of the position of Chief Engineer of the Pere Marquette Ry. to become General Manager of the Canadian White Co. was mentioned in our last week's issue, has been actively engaged in railroad construction from the time he finished his education at the University of Michigan and the Ohio State University. During the four years that he was employed by the Norfolk & Western R. R. he had charge of the field work on the construction of their terminals at Columbus, O. For two years he was with the Engineering Department of the Hocking Valley R. R., and has held the position of Engineer of Maintenance of Way for the Cleveland, Akron & Columbus Ry., and also the Wheeling & Lake Erie Ry. In 1900 he was appointed Division Engineer of the Pere Marquette Ry., and in two years he was promoted to the position of Chief Engineer of that road. During this time the railroad was reorganized and extended into Chicago and Buffalo, involving the construction of new line and terminals. New shop buildings and yards at Grand Rapids, Mich., and new shops at St. Thomas, Ont., have just been completed under his supervision.

Obituary.

Henry F. Kilburn, a well-known architect with offices at 156 Fifth Ave., New York, died Sept. 26 in New York Hospital after a long illness. He was about 60 years old.

Richard English, a contractor and builder died Oct. 1 at his home in Jersey City, N. J., aged 67 years. Among the buildings he erected were the City Hall and half a dozen schoolhouses in Jersey City.

William B. Rankine, vice-President of the Niagara Falls Power Co. and the Canadian-Niagara Power Co., died last week at Franconia, N. H., of heart disease, aged 47 years. He was a graduate of Union College, class of 1877, and was a trustee of that institution at the time of his death.

Richard A. Healy, a mechanical engineer and inventor died suddenly Sept. 26 in Paterson, N. J., aged 66 years. For many years he was employed at the Cooke Locomotive Works, where he invented numerous appliances for locomotives. For a number of years Mr. Healy had been head of the engineering department of the J. C. Todd Works.

Thayer B. Hamilton, a civil engineer, of Beaver, Pa., died Sept. 16 at the Passavant Hospital, Pittsburg, Pa., of injuries received from an explosion of gas in an abandoned coal mine at Port Royal. He was a member of a corps of engineers which was surveying a branch line in the Youghiogheny Valley for the Pittsburg, Virginia & Charleston R. R. He was 23 years old.

Sutherland M. Prevost, third vice-President of the Pennsylvania R. R. Co., died Sept. 30 at his home in Philadelphia of a complication of diseases. He was 60 years old. Mr. Prevost was graduated from the Polytechnic College of Philadelphia, and in 1864 began his railroad career as a rodman in the engineering corps, which constructed the Philadelphia & Erie R. R. In 1871 he was appointed an Assistant Engineer on the Pennsylvania R. R., and subsequently became Superintendent of the Bedford, the Middle and the Philadelphia Divisions. In 1882 he was appointed General Superintendent of Transportation of the Pennsylvania R. R., and in 1893 he was made General Manager. He became third vice-President in 1897, and in that office was chief executive head of the Traffic Department. Mr. Prevost was also vice-President of various subsidiary companies of the Pennsylvania R. R., and at one time was a Director of the Consolidated Lake Superior Co.

ENGINEERING SOCIETIES.

COMING MEETINGS.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 17. Annual meeting at Pittsburg, Pa. Secy., R. F. Patterson, Concord, N. H.

LAKE SUPERIOR MINING INSTITUTE.
Oct. 17, 18. Annual meeting on the Menominee Range, with excursion. Secy., A. J. Yungbluth, Ishpeming, Mich.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

MICHIGAN ENGINEERING SOCIETY.—The Board of Directors of this society, at a meeting held at Lansing, Mich., on Sept. 20, canvassed a letter-ballot of the Society for officers for the coming year. The result of the canvass is as follows: President, Professor H. K. Vedder (Ann Arbor): Vice-President, Professor A. C. Lane (Lansing); Secretary and Treasurer, Mr. F. Hodgman (Climax); Directors, Messrs. M. C. Taft (Kalamazoo), B. E. Parks (Detroit), W. W. Brigden (Battle Creek). The annual meeting will be held the second week of January, 1906, at Lansing.